For more information go to www.barbourproductsearch.info

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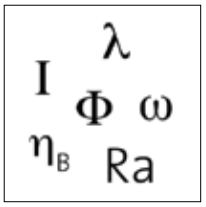

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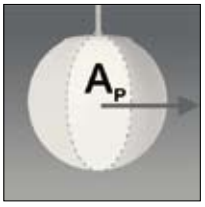

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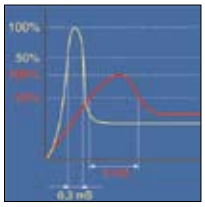

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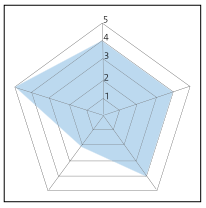

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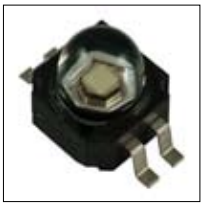

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Modern lighting control systems can improve the quality of the lighting. Using dimmable luminaires means the lighting is targeted in the right place, at the right time and at the right intensity. In combination with light sensors daylight can be utilised which saves energy. In many buildings the lighting requirement changes several times during the course of a day. The application of light control is therefore an important factor in areas such as, conference rooms and restaurants. An installation with pre-programmed lighting levels, lighting scenes, together with a remote control allows the lighting systems in these types of premises to be utilised to the full.

Constant light level – e-Sense

Many of Fagerhult's luminaire models can be fitted with a light sensor. Using the sensor, the level of artificial light is adjusted according to the daylight. An increase in daylight turns down the artificial lighting, which saves energy. This means the illuminance on the working surface can be maintained at a constant level irrespective of the time of day. Sensor operation varies a little between different manufacturers. More advanced sensors also offer more functionality such as occupancy detection and IR-receiver.

Occupancy detection – e-Sense

Occupancy detectors register, using thermal radiation from individuals, movement within the supervised area. The supervised area is only lit when occupied. Greater sensitivity is needed on an occupancy detector for indoor lighting than for corresponding outdoor lighting as the detector must also detect small movements from an inactive person. Sensors for occupancy detection are also available combined with other functions such as light level control and IR-receiver.

Dividing into channels

Today's modern light control systems permit several luminaire groups or channels to be controlled centrally from one or more places. Using a traditional control unit, such as a dimmer integrated in a pattress box, all luminaires connected to the same channel are regulated. This is known as 1-channel control. With more advanced systems different channels can be embraced and controlled individually or together.

Lighting scenes

Light control systems also offer the possibility to save pre-selected lighting scenes. These scenes can either be divided up on a channel level or in combination with a master system that controls all the channels in the system. The required lighting scenes are selected via wall panels or remote controls, and the system automatically sets the pre-selected lighting level for each lighting group.

Control via computer

Digital control gear can be controlled via an interface from a computer via a software programme which provides the opportunity to control lighting systems in the same way as using wall panels. The DALI-system needs to be programmed and larger systems are ideally programmed using a computer. The leading manufacturers have developed software, which can be downloaded free of charge from their websites on the Internet.

Remote control gives freedom

The right lighting scene or light level can be easily set using a remote control. Even individual control of channels is possible. Naturally all lighting can be switched on and off with the remote control. Remote controls usually function via infrared light. There are also systems available on the market that only switch the lighting on and off.

The DALI-system can be programmed with a remote control but for larger systems programming from a PC with appropriate software is preferable.

Technical limitations

Some systems for lighting control require a separate central or master units. However in the DALI-system the logic is distributed amongst components in the system, thus a separate central control unit is not required. Luminaires require a special control circuit, a two way control conductor, which may require older lighting systems to be supplemented. Older light control systems can usually be upgraded with new luminaires by using an interface that converts, for example, analogue signals to digital.

Glossary

Dimming
Variable regulation of the luminous intensity.

Light control
System that controls individual luminaire groups and/or complete systems.

HF-ballast for dimming
Control gear that via a separate control circuit allows dimming.

Digital light control
Control signals between the units are transferred in the form of digital commands. Commands in digital form are less sensitive to disturbances than analogue systems.

Analogue control
Analogue systems are usually based on 1–10 V DC between the controller and luminaire. The system either regulates the voltage or resistance in the control circuit.

The length of the control conductor can affect the control result.

Phase control (impulse)
A system based on control of the lighting level via 240 V (for example, with the help of a momentary wall switch or with an integrated pull cord switch in the luminaire). Known best as switchDIM. The system requires 4 conductors to the luminaire if a wall switch is used.

Addressed control
The units in the system can be individually addressed enabling them to be controlled independently of each other. The digital DALI protocol is addressable.

Multi-channel control
An installation can be divided into different groups, channels, which can be controlled independent of each other or together.

Lighting scenes
A pre-selected lighting effect/arrangement that can be easily recalled if necessary.

Constant light level
The system attempts to maintain the luminous intensity within the required area (for example, under the luminaire) at a constant level. The level of the artificial lighting is affected by the incident daylight. Used to save energy.

Occupancy detector
A detector that senses an individual's thermal radiation. A movement within the detector's supervised area switches on the luminaire. An integrated timer switches off the luminaire if no movement is detected within the sensor's supervised area.

IR-receiver
Receives the remote control's signals and transfers these to the system. Usually integrated in a wall panel or multisensor.

Multisensor
Sensor that usually includes the functions constant light level, occupancy detector and IR-receiver.

For more information go to www.barbourproductsearch.info

Incandescent and low voltage light sources

The simplest way to dim an incandescent lamp is to use a thyristor, or phase control. The thyristor clips off the leading edge of the sin wave. Control of low voltage light sources, such as halogen, requires a controller that is compatible with the transformer being used.

Transformers with iron cores, conventional transformers, are regulated using a thyristor while electronic transformers generally demand a transistor controller. These controllers clip, unlike thyristors, the trailing edge of the sin wave. There are also electronic transformers on the market that can operate both types of controllers.

Fluorescent lamps

Control of fluorescent lamps requires the light source to be operating on control gear adapted and intended for dimming. It is not possible to dim a light source that is operating on conventional control gear. In general there are four different control methods for fluorescent lamps – highlighted below.

Control method refers to the type of signal transfer used between the control unit/controller and the electronic control gear in the luminaire. A number of the most common control methods are highlighted in the table below.

The selected method also effects, apart from the components included in the system, how low the lighting can be regulated, how the installation is performed and the cost of the system. Digital systems are generally more expensive than analogue, but they offer technical and functionality advantages that truly substantiate the extra cost.

In some applications it may be beneficial to combine digital systems with basic analogue systems. Read more about this on the DALI page.

Characteristics	DALI	DSI	Phase control (impulse)	1–10 V
Addressable luminaire control	64	No	No	No
Group addresses	16	No	No	No
Logaritmic control	Yes	Yes	Yes	No
Control circuit polarity dependant	No	No	-	Yes
Switched off via the control circuit	Yes	Yes	Yes	No
Number of conductors to the luminaire	5	5	4	5
Control circuit in same cable, max length	300 m	250 m	Unlimited	300 m
Multi-channel systems require an external central unit	No	Yes	Single channel	Yes

DALI
(Digital Adressable Lighting Interface)

Advantages:
- Components from several different manufacturers can be included in the same system.
- Each unit in the system is adressable.
- Easy to modify and expand.
- Only one pair of control conductors even in multi-channel systems give lower installation costs.
- Polarity free control conductor reduces the risk of wrong connections.
- Can be controlled via an interface by a computer.
- Can be connected to a BMS-system (LonWorks, EIB) via a gateway.

Note:
- The system must be programmed before commissioning.
- Programming is performed in different ways for products from different manufacturers.
- Max 64 addresses/system (Note that the interface for programming via a computer requires an address).
- Large systems can be built up via software/servers/gateways. This type of system usually utilises existing data networks (TCP/IP). An example of this type of system is winDIM@net from Tridonic.

DSI
(Non-addressable digital control)

Advantages:
- All luminaires are controlled in the same way thanks to digital data transfer.
- Polarity free control conductor reduces the risk of wrong connections.
- Can be controlled via a computer.

Note:
- Components in the system are not addressable.
- Multi-channel systems require each channel to have a separate control conductor.
- Only one manufacturer of the system.

Phase control
(Impulse – For example, switchDIM)

Advantages:
- The system does not need an advanced control unit.
- Standard momentary switches can be used.
- Only one extra phase conductor is required in the control circuit.

Note:
- Wall switches must not be fitted with an indicator.
- Max 25 HF-ballasts/system recommended.
- Avoid mixing different brands in the system.

1–10 V
(Analog)

Advantages:
- Known system that is easy to understand.
- Control units available from most manufacturers.

Note:
- Some analogue 0–10 V control systems on the market are not appropriate for the control of control gear for 1–10 V DC as set out in EN 60929.
- The length of the control conductor can affect the control result.
- 1–10 V systems can only be controlled from one location (one control unit).

For more information go to www.barbourproductsearch.info

DALI (Digital Addressable Lighting Interface) is a standardised digital protocol for dimming. DALI is supported by the major manufacturers of HF-ballasts in Europe (Helvar, Osram, Philips and Tridonic). Other companies within the lighting industry have also joined the group of DALI-manufacturers.

DALI uses a single multi-core cable through which a duplex digital signal is transferred between all units in the system. Connected HF-ballasts, control panels, sensors and the programming units communicate with each other. The "intelligence" is distributed, (read stored) in the system's different component parts. This creates greater safety and reliability as the system is not dependent on any central unit.

The DALI-system is also very flexible and future-proof as any change to the design of the premises or usage, results only in the need to reprogram the settings. Generally the cabling does not need to be changed.

In the DALI-system information is transferred between components via an addressed digital signal. As the signal is digital all included luminaires are controlled in exactly the same way, irrespective of the distance between the control unit and luminaire. The HF-ballasts used in DALI are adapted to the sensitivity of the eye for light level adjustments, a.k.a. logarithmic compensation.

Apart from the phase, neutral and earth conductors, two other wires for the digital signal are connected to the luminaire. These cables are polarity free which simplifies installation.

The digital control signal is also insensitive to external disturbances. The lighting is switched on and off by means of a digital command via the DALI-conductors. It is therefore beneficial to connect the mains voltage directly from the fuse panel to the luminaire.

Combining DALI with other control systems

DALI can easily be combined with other control systems such as analogue 1–10 V. When there is no need to control or monitor an individual luminaire, or when existing rows of luminaires are to be incorporated into the new control system, it may be possible to use, for example, a DALI to 1–10 V interface (converter). The existing luminaires, equipped with HF-ballasts for analogue 1–10 V dimming, are connected to a DALI to 1–10 V interface. Using this solution the luminaires can be controlled centrally via DALI-panels for example. The solution is more economical and it also significantly increases the number of luminaires that can be controlled in a DALI-installation. This is because a single DALI address now controls several luminaires. The same solution can be used with luminaires equipped with HF-ballasts for DSI dimming, with the help of a DALI to DSI interface.

Helvar have chosen a solution where, via the HF-ballast, you have the possibility to supply power to the DALI-system. The use of this function however, requires the total current in the control cables to be calculated, with regard to all the components included in the system.

As standard, Fagerhult have chosen to supply all luminaires with Helvar's DALI-ballasts with an integral power supply. This is to enable a system with a central DALI power supply to incorporate luminaires with different brands of DALI-ballasts.

However, luminaires without an integral power supply are available on request.

Advantages of the DALI-technology

- Addressability. Possibility to individually control different luminaires/HF-ballasts in the same system. Max 64 addresses/system.
- Light scenes and groupings. Possible to pre-program different light scenes. Up to 16 groups of luminaires and 16 different light scenes can be created in each system.
- Ignition and extinguishing of luminaires takes place via digital commands.
- Control conductors for the digital signals have no polarity (positive/negative), which reduces the risk of incorrect connection.
- The digital control signal is not sensitive to disturbances transferred from other conductors. The control conductor can be routed together with the main voltage conductors without the risk of disturbances (note however that the control conductors should also be of a heavy current type).
- Duplex communications via the control conductors is possible. Status and any error indications from components in the system can be gathered by any connected software.
- The control signal is transferred in the same way to all luminaires independent of the control conductors' length.
- Digital technology also allows the system to be controlled via computers.
- DALI can also be integrated with a BMS system (for example, LonWorks).
- Multiple DALI systems can be controlled over routers connected to an Ethernet network.

Note

- Programming is carried out using wall panels, remote control units or with the help of computers and software. The use of software is recommended for all large installations.
- DALI requires the control circuit to be fed with a current. This current may be max 250 mA, which is obtained by means of an external DALI power source. A high current in the circuit results in a communications breakdown or damaged components. Consequently, it is important that a DALI-system is planned and dimensioned correctly.
- Maximum cable length for the control circuit is 300 m.
- The characteristics of the units from different manufacturers deviate slightly.

For more information go to www.barbourproductsearch.info

Installation of light control in a classroom

A classroom is a workplace for both teachers and pupils. Good lighting is essential for the varying work. Through advances in lighting technology a combination of preferable light levels and energy efficiency can be offered through controls. The right distribution at the right level of light contributes towards a better learning environment.

Advantages:

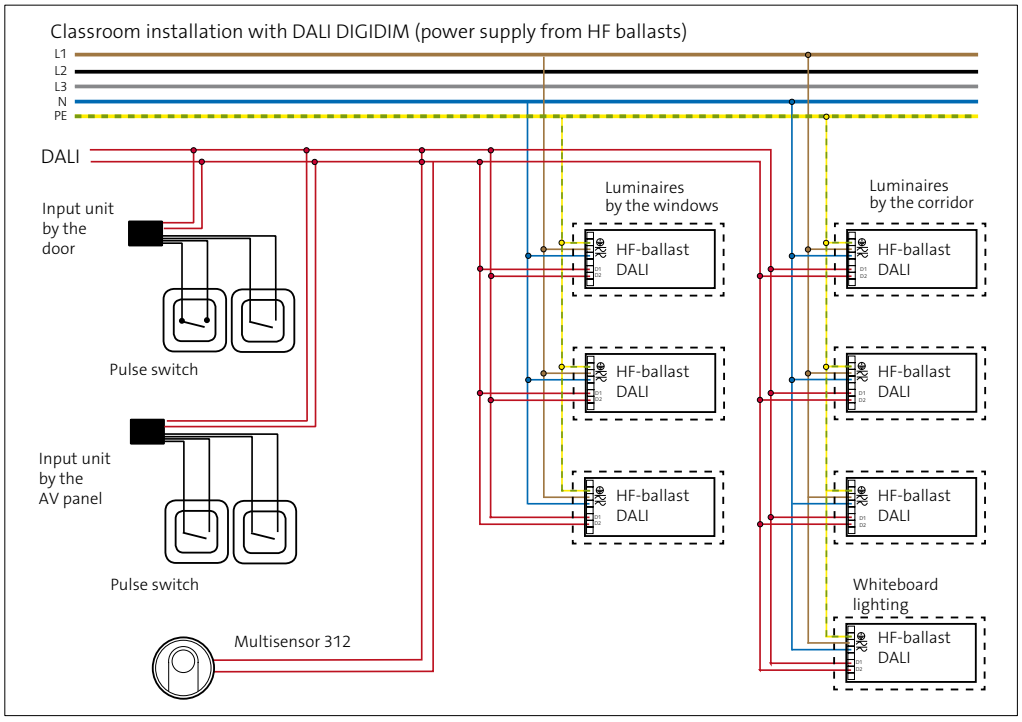
- Automatic switching on/off or only switching off.
- Individual control and adjustment of the ceiling and smart board lighting.
- Daylight control.
- Control by door and AV panels.
- Control integrated in standard pushbuttons.
- Lighting scenes.
- PC programming.

Proposal for the installation of control in classrooms

Programmable control in a classroom allows exact control operations to be produced which directly correspond with the user requirements. Maximum and minimum levels can be changed and the luminaires can be programmed individually. Switching functions can be changed and adapted to the function of the room.

Programming requires the temporary connection of a computer with a Windows-based PC program. The possibility exists to transfer program functions from one classroom to the next, which means all functions are the same and the time for programming is reduced significantly. Other advantages can be achieved by connecting the heating and ventilation to the occupancy control. See the wiring diagram below.

Product	
Combiform Class 2x35 W with DALI-ballast	**20316-368**
Multisensor 312	**86122**
Input units for control	**86148**



Installation in a classroom with DALI DIGIDIM. Programming via a PC-program. Power supply can be used from Helvar's EL-si DALI HF-ballast. The different control functions have been connected in parallel to the DALI control cables. All luminaires are controlled in common via a daylight sensor, except the whiteboard lighting. Lighting is switched on manually. All lighting is switched off together. The size of the classroom determines whether one multisensor is sufficient for occupancy detection, or whether the installation needs to be supplemented with additional units. The ceiling and whiteboard lighting can be controlled individually by the input units connected to the impulse switch by the door and AV panel.

For more information go to www.barbourproductsearch.info

Components from Helvar

Designation	Function	
Control panels 200-series (white thermoplastic)		
DIGIDIM 126200	Control panel with 8 controls	**86143**
DIGIDIM 125200	Control panel with 7 controls	**86137**
DIGIDIM 100200	Control panel with rotary controls	**86144**
DIGIDIM 111200	Control panel with 2 sliders	**86145**
Phase regulators		
DIGIDIM 452	Leading and trailing edge control, max 1000 W	**86146**
Multisensor		
DIGIDIM 312	For constant light, with occupancy detection and IR-receiver. Recessed mounting, cut out Ø 55 mm	**86122**
Power supply		
DIGIDIM 402	Supplies max 250 mA to the control circuit	**86123**
Remote control		
DIGIDIM 303	IR-remote control	**86121**
Relay & input unit		
DIGIDIM 494	For max 10 A resistive load or 6 A inductive load	**86147**
DIGIDIM 444	Input unit for optional switches or other control	**86148**
Gateways		
DIGIDIM 472	Converts DALI to 1–10 V DC, DIN rail mounting	**86136**
DIGIDIM 410	For connecting a DALI-system to 1–10 V DC	**86120**
DIGIDIM 430	For connecting a DALI-system to LonWorks	**86149**
Interface		
DIGIDIM 505	Serial interface for PCs. Used together with the Helvar Toolbox software	**86124**

Components from Fagerhult

Designation	Function	
Control panels		
DALI Touch panel	Programmable DALI panel with pushbuttons.	**18595**

Components from Tridonic

Designation	Function	
Control panels		
DALI GC	Two channel control module. For use with standard momentary heavy current switches from various suppliers. Installed in the same box as the push-button.	**86125**
DALI SC	Control module for four scenes. For use with standard momentary heavy current switches from various suppliers. Installed in the same box as the push-button.	**86126**
Power supply		
DALI PS1	Supplies 200 mA to the control circuit	**86127**
DALI sequence module		
DALI SQM	For automatic sequence control of DALI units, e.g. LEDs with RGB colours.	**86214**
Interface		
DALI SCI	Serial interface for PCs. Used together with the Tridonic winDIM software.	**86129**
DALI USB	Interface for Tridonic software WinDIM and ConfigTool. Connects to the PC's USB port. Replaces the previous DALI SCI except when using the Light Over Time function.	**86182**

Note: It is not possible to mix control components from different manufacturers in the same DALI-system.

Components from Osram

Designation	Function	
Rotary potentiometer		
DALI MCU rotary potentiometer	Rotary potentiometer with integrated power supply for 25 DALI units.	**86212**

Note: It is not possible to mix control components from different manufacturers in the same DALI-system.

DALI Touch panel

DIGIDIM 200-series control panels

DIGIDIM 312 multi-sensor

DALI MCU rotary potentiometer

DIGIDIM 444 – input unit

DALI SC – scene module

DALI Touch panel
Fagerhult has designed and developed a pushbutton panel offering unique functions and options. Originally the panel was developed to meet the requirements of a hospital environment where the label on each individual pushbutton needs to be easy to read.

Pushbuttons for lighting control can be designed for a variety of environments and needs. Being able to see the various functions and which was most recently activated always comes down to two fundamental requirements.

A pushbutton panel that has a number of buttons must have diodes to show the selected function, as well as clear, legible text indicating the function of each button. This panel also has membrane pushbuttons, which are easy to clean. To identify each function simply print out the required text using a labelling device such as DYMO or Brother, 8 mm text width. The text strip should be applied from the reverse side of the panel before fitting. NB! do not remove the cover strip on the tape side!

DIGIDIM 200-series panels
Control panels for assembly in standard pattress boxes. Face of white thermoplastic. The pushbuttons' or controls' functions can be programmed to control an individual luminaire, a luminaire group, a complete DALI-system or recall a pre-set lighting scene.

DIGIDIM 452
Digital single channel phase regulator for incandescent and halogen lamps. Leading and trailing edge control can be selected using a switch. Lacks a power source for DALI. For 230–240 V/50–60 Hz.

DIGIDIM 312 multi-sensor
Multi-sensor with the functions (selectable) constant light, occupancy detection and receiver for remote control (IR). The unit is recess mounted. Hole diameter 55 mm. Sensing range 50–5000 lx, 100 or 40 degrees detection and elliptical sensing area.

DIGIDIM 444 input unit
The input unit allows the connection of optional switches or other external connections to a DALI system.

DIGIDIM 402 power supply
Power source for DALI. For DIN rail mounting. 220–240 VAC, 50–60 Hz.

DIGIDIM 303 IR-transmitter
For scene selection and/or channel control. Can also be used as a programming unit on installations with luminaires equipped with a Helvar DIGIDIM system. Requires the system to be equipped with Helvar's wall panel or multisensor with IR-receiver.

DALI SQM sequence module
For automatic sequence control of DALI units, e.g. LEDs with RGB colours. The unit alternates light scenes which must be pre-programmed using the DALI DIGIDIM Toolbox or WinDIM software. The sequence can be started/stopped by an external function such as a time switch.

DALI SC
Four scene control module for push-button mounted in pattress box. Installed in the pattress box behind the switch. Suitable push-buttons are standard momentary heavy current switches from various suppliers.

DALI GC
Two channel control module for push-button mounted in a pattress box. Installed in the pattress box behind the switch. Suitable push-buttons are standard momentary heavy current switches from various suppliers. Capable of igniting, extinguishing, dimming, addressing and grouping the DALI system.

DALI PS1
Compact and enclosed power source for DALI that can be fitted, for example, in a suspended ceiling. 120–240 V AC, 50–60 Hz.

Rotary potentiometer DALI MCU
Rotary potentiometer with built-in power supply to 25 DALI devices. Connected to 230 V and DALI. Two MCU can be connected to power to a maximum of 50 DALI devices. Four potentiometers can be connected in parallel for control from multiple locations. Potentiometers MCU should not be combined with other DALI controllers.

Subject to alteration. For further specifications see www.helvar.com and www.tridonicatco.com.

For more information go to www.barbourproductsearch.info

DALI Router 910

The new router system for DALI uses Ethernet communication as a smooth way of connecting DALI networks together. The modules provide a complete system from single office rooms to large office buildings. The basic functions are available and ready to start without any programming. For advanced functions, the Windows-based software Designer is used. Each individual router can handle two DALI circuits, each with a maximum of 64 control units and load interfaces. The system can be programmed for energy-saving functions such as occupancy detection and constant lighting. Further automatic functions are possible with planned events. The OPC server software activates interfaces with the processing system in the building.

Superb reliability

All data is stored in the system itself, the need for PC control in daily usage. Eliminating the central control arrangement ensures that no single product can cause a breakdown of the system. If necessary, a PC can be connected to the system for diagnostic purposes.

Advantages

- No PC required for daily usage.
- Complete flexibility.
- Standard protocol.
- Simple system layout.

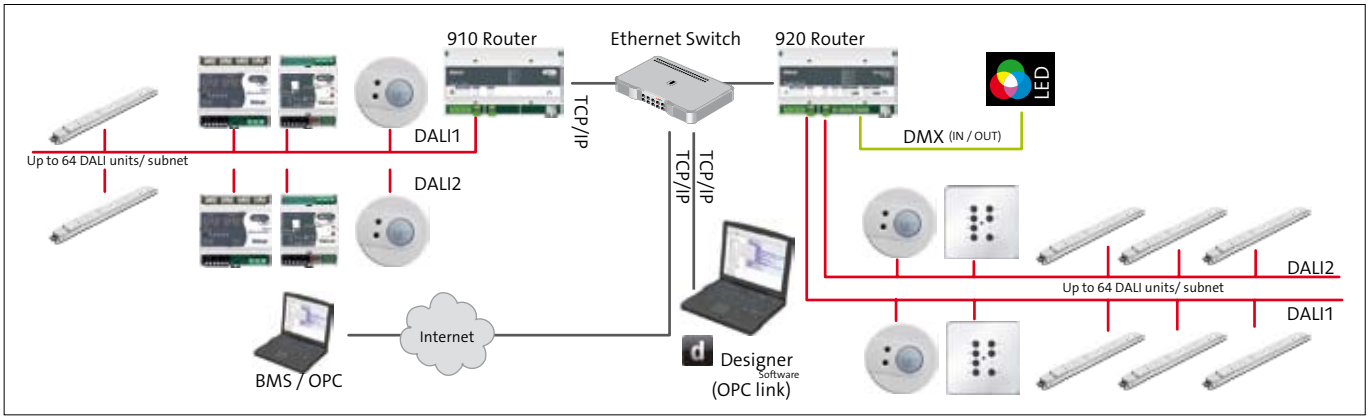
System fundamentals

The router is the central unit in the system providing a smooth connection between a large number of DALI and DIGIDIM products. DIGIDIM systems are programmed using Helvar's Designer software, which can be used on a local or remote-controlled Windows-based PC. Once programming is complete, the PC can be disconnected as it is not required for normal daily system usage. The PC can also be used to monitor and report on the status of the system. All data are stored in flash memory in the DIGIDIM routers, which avoids the need for cumbersome databases and allows the system to be saved to a PC as back-up.

Network of several routers

A large number of routers can be interconnected in a network of standard Ethernet connections. This means it can be used for programming and monitoring. The extent of the system is defined as a work group. A work group is a collection of routers joined via an Ethernet connection.

DALI Router 910		
Designation	Function	
DALI Router 910	Ethernet router for DALI	**86195**



Key figures

- A DIGIDIM router can handle 128 DALI units.
- Each DALI network can have 64 DALI units connected, with a maximum length of 300 metres.
- Integrated 250 mA DALI power supply for each DALI network.
- 10/100 Mbit/s Ethernet connection with Internet protocol (TCP/IP).
- 16,000 groups in Designer software.
- Each router can use 256 groups.
- DALI units work together in groups.
- A maximum of 64 PCs running Helvar's Designer software may be connected at the same time.

Functions

- Manual control (always the option of adjusting the light in person).
- Daylight control (adjustment according to incident daylight. Both open loop and closed loop).
- Occupancy detection (in multi-sensor or external units).
- Lamp status (each DALI unit can provide information).
- Log for life span of light sources (consumption by individual light sources can be logged in a journal).
- Automatic updating when an HF-ballast is changed (information for the removed ballast is updated in the new one).
- Timer functions (automatic on/off or change of functions depending on time).
- Calendar functions (events may occur on specific days of the week).
- Automatic sequence control (e.g. daylight simulation).
- Blocking function for corridor lighting (always corridor lighting when office is occupied).
- Logic functions (AND & NAND-like functions).
- Automatic control of emergency lighting units (meets the DALI standard for the control of emergency lighting units).
- OPC functions (control between property systems and servers).
- Multiple offset controls (constant light adjustment provides higher level of lighting away from windows).

For more information go to www.barbourproductsearch.info

HF-ballasts for DSI-control are only manufactured by Tridonic. Control information in the DSI system is transferred to the HF-ballast via a non-addressable digital signal. One benefit of digital control is that it is independent of the control circuit's length and resistance. All luminaires connected to the system are controlled in the same way irrespective of the distance between the control unit and the luminaire. Digital control also allows more flexible control of the light sources. As a result, the HF-ballast is regulated according to the eyes sensitivity.

Apart from the phase, neutral and earth conductors, two other wires for the control circuit are connected to the luminaire. The control bus is polarity free, which facilitates installation. The control and mains voltages to the control unit can be routed in the same conduit or cable sheath over a length of up to 250 m, as the digital signal is fairly insensitive to disturbances.

The lighting is switched on and off by means of a digital control command, permitting the mains voltage to be connected directly from the fuse panel to the luminaire. There is a constant supply to the luminaires, even when switched off. The minimum level is dependent on the type of light source 1 %, 3 % or 10 %.

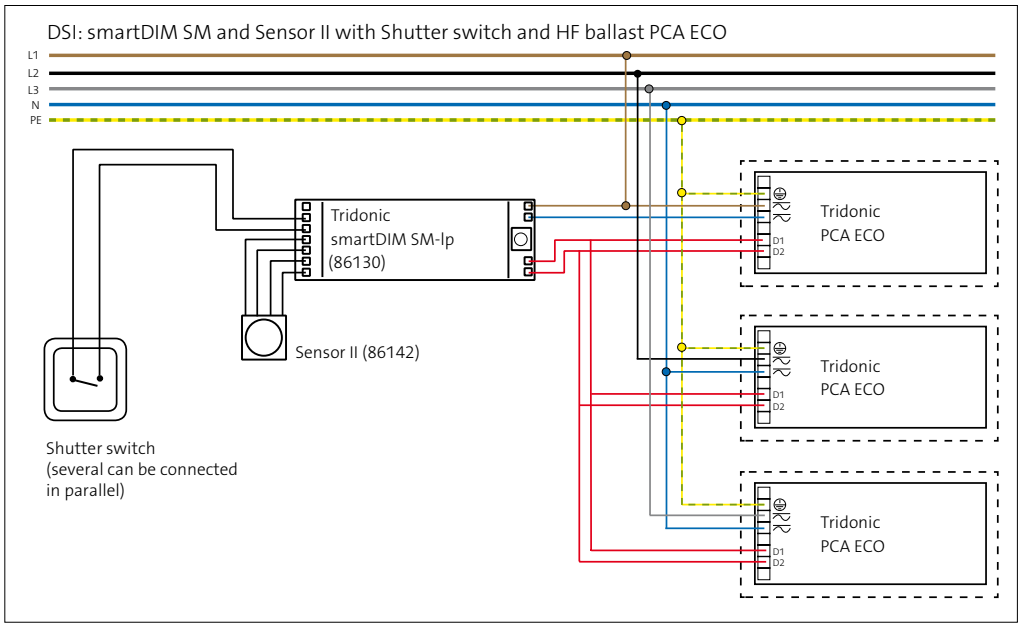
DSI control gear

Tridonic manufactures two ranges of dimmable control gear, Excel and Eco. In addition to all the features available on the Eco model the Excel unit also has the capability to interpret DALI commands, the possibility to program parameters and the ability to transmit error messages.

Note

DSI control is non-addressable.

The luminaire/group can also be computer controlled using the winDIM-software. This requires the computer to be connected to the luminaires bus-system via a winDIM cable. The winDIM software is available via the Internet www.tridonicatco.com.



A larger system can be created for daylight control with manual control and occupancy detection by using Tridonic smartDIM SM. Manual control with retractable switches or shutter switches. Different functions for occupancy and automatic switching on can be selected by means of DIP-switches on the control unit. Several sensors can be connected in parallel, but only one should be connected for daylight control. Maximum 25 HF-ballasts can be connected to one control. Different phases can be used to the luminaires.

For more information go to www.barbourproductsearch.info

Control unit

Component	Channels	Luminaires	Dimensions	
modularDIM Basic	3	3x100 pcs.	90x71x59 mm	**86131**
DSI-V/T	1	50 pcs.	190x30x28 mm	**86109**
smartDIM SM-lp	1	25 pcs.	190x30x21 mm	**86130**
DSI-AD	1	50 pcs.	190x30x28 mm	**86134**
DSI-Smart multi-sensor	1	4 pcs.	Ø 60 mm, h 47 mm	**86133**
DSI-ADS	1	100 pcs.	For DIN rail	**86135**

Dimmable transformers

Component	Output	Sec.voltage	Dimensions	
TE-DC	300 VA	11.9 V	254x147x59 mm	**86156**

Phase regulators

Component	Output VA	Load	Dimensions	
PHD	30–300	Magnetic	220x40x31 mm	**86157**
PD-TD	30–1000	Magnetic	140x90x59 mm	**86138**
PAD-TD	30–1000	Electronic	140x90x59 mm	**86139**

Constant light control

Component	Connection	Dimensions	
Smart-LS II	PCA-Eco/Excel	Ø 18 mm, h 16.1 mm	**86158**
modularDIM DM	modularDIM Basic	17x90x58 mm	**86140**
Daylight Sensor	modularDIM DM	Ø 52 mm	**86163**

Lighting scenes

Component	Connection	Dimensions	
modularDIM SC	modularDIM Basic	71x90x59 mm	**86141**

Multisensor-sensor

Component	Connection	Dimensions	
smartDIM sensor 1	smartDIM SM	30x30x25,2 mm	**86159**
smartDIM sensor 2	smartDIM SM	Ø 60 mm, h 23.2 mm	**86142**

modularDIM Basic

smartDIM SM-lp

smartDIM sensor 2

Daylight Sensor

DSI-AD

SMART LS II

modularDIM
3-channel control unit for DIN rail mounting. Common or individual control of all channels with pushbuttons or occupancy detectors. Can be expanded with control of 4 lighting scenes (modularDIM SC) or constant light control (modularDIM DM and Daylight Sensor).

smartDIM SM
Single channel control unit, which can be mounted in a suspended ceiling or luminaire. Controlled with a pushbutton in combination with an occupancy and daylight sensor, where Sensor 1 is intended for mounting in the luminaire and Sensor 2 in the ceiling area.

DSI-AD
Single channel control unit, that can be mounted in a suspended ceiling or luminaire. Enclosed connections with strain relief. Potentiometer control with EN 60929 compliant 1–10 V potentiometer controller, such as Helvar TK4 or Ensto Busch-Jaeger 2112.

DSI-AD/S
As DSI-AD but designed for DIN rail mounting. With bracket for DIN rails.

DSI-Smart
Independent multisensor for control of a maximum of four luminaires. Includes an occupancy detector, daylight sensor and receiver for an infrared remote control.

SMART LS II
Daylight sensor that can be connected directly to PCA-Eco and PCA-Excel ballasts, these are fitted on the luminaire or directly to the fluorescent lamp using a clip. Controls one HF-ballast.

Modules for BMS communication

DSI-EIBS
Single channel gateway for EIB to DSI communication.

DSI-LON/S
3 channel gateway for LonWorks to DSI communication.

More information is available at www.ljuskontroll.com

For more information go to www.barbourproductsearch.info

Phase control (impulse) is a simplified and economic version of light control, using controllable HF-ballasts designed for this function. Normally, these ballasts can also be controlled via a bus system such as DSI, DALI or 1–10 V DC depending on the brand and type. However, the functions cannot be combined as this can result in considerable damage.

Phase control (impulse) does not require a regulator or other controller, the signal to the HF-ballast is obtained directly from a simple momentary switch. Other additional modules are not required. In effect, the regulator is integrated in the HF-ballast.

Only a four core cable to the luminaire is needed: Direct (unswitched) mains voltage, neutral and protective earth as well as the mains voltage (impulse) via the momentary switch. Control of a luminaire mounted on a traditional connection box and requires little change to the cabling.

Phase control (impulse) is also an ideal system when you want to control a lighting system from several places in the room. Reliability lies in its simplicity and the lack of intermediate units means installation is easy and inexpensive.

The control method can, depending on the brand, be combined with other components such as daylight sensors. The Tridonic brand, for example, offers interaction between phase control (impulse) and the sensor SMART LS II. The pre-set lighting level is set using the momentary switch, to the required value. The sensor will then attempt to keep the level constant around the new level. The lamp output returns to the pre-set value once the luminaire has been switched off and then on again.

Control switches can comprise of 250 V switches with normally open contacts and impulse springs, or switches with a return spring. When using such a switch, the luminaire is turned on and off by quickly pressing and releasing the switch, while adjustment of the illumination level, alternating up and down, is performed by pressing and holding down the switch.

Alternatively a momentary switch can be used, where one button regulates the luminous intensity up and the other down. The lighting can be switched on and off with either button.

Applies to Tridonic SwithDIM:

- Unlimited number of parallel connected pushbuttons for on/off/dimming can be installed.
- A maximum of 25 PCA HF-ballasts are recommended in a switchDIM installation.
- Connection of the pushbutton phase and neutral to the HF-ballast is polarity free.

Note

- Control switches must not be equipped with indicator lamps, as the leakage current from these cause malfunctions.
- The maximum length for the control cable is normally unlimited as the signal is a 230/240 V signal impulse.
- The same phase should be used for control as well as the power supply to the luminaire. This produces an unpolarised connection, which means that the luminaire can also be equipped with a plug. A 3-phase connection is also possible, but this requires a special polarised connection.
- Simultaneous use of phase control (impulse) and another control method such as DALI or DSI will cause irreparable damage to the digital control equipment.
- Avoid mixing different brands in the system.

If a PCA HF-ballast with switchDIM is not synchronised with other installed PCA HF-ballasts (ballasts on same circuit at different phases on the upward/downward dimming cycle) the installation can be synchronised by depressing the pushbutton for > 10 seconds. All PCA HF-ballasts will then be synchronised at the 50 % level whereupon the installation can be used again as usual. Synchronisation can be carried out at any time during normal operation.

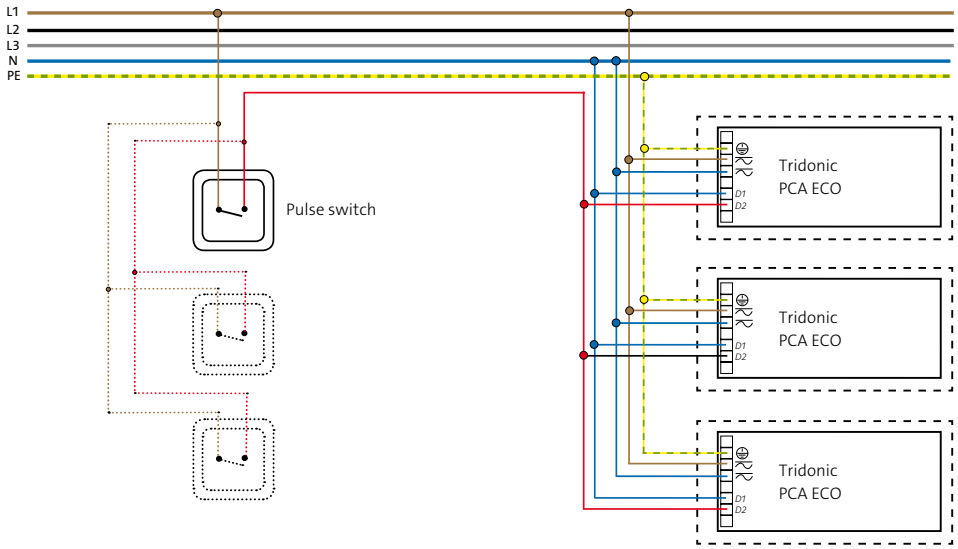
Absence dampening – new function

The new HF-ballasts from Tridonic PCA ECO and Excel can also be used for dimming between a high level (occupancy) and low level (absenteeism) via occupancy detectors. A perfect function for stairwells, corridors and culverts. Large amounts of energy can be saved in this way, without extinguishing the light completely.

See the installation example on page 464.

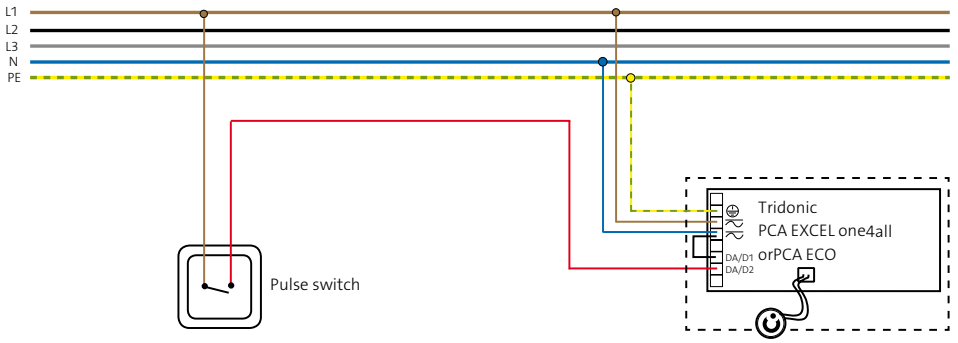
For more information go to www.barbourproductsearch.info

switchDIM control with retractable switch HF-ballast PCA ECO



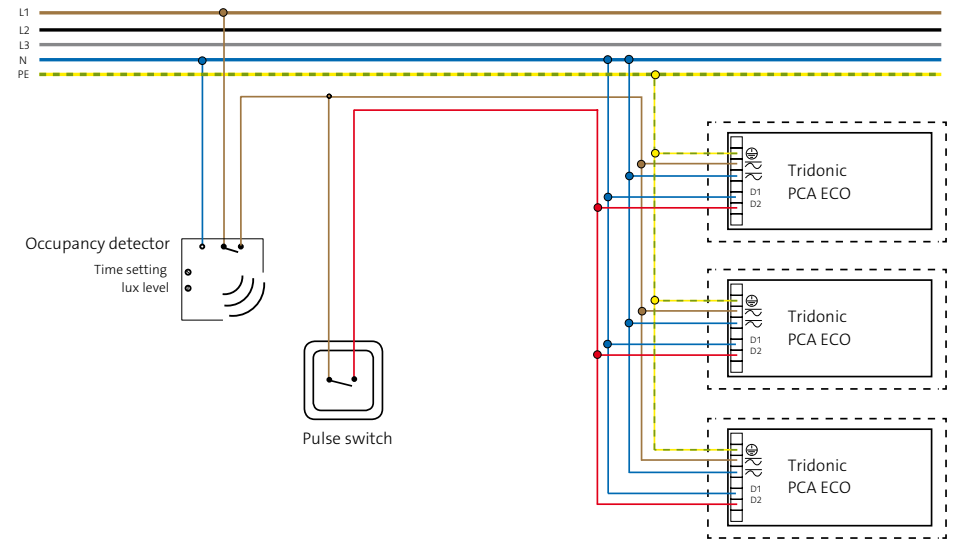
A retractable switch without indicator lamp must be used. Maximum 25 HF-ballasts can be connected to one control. The same phase must be used for control and feeding the HF-ballast. If several HF-ballasts or more advanced control is required, please contact your Fagerhult representative.

switchDIM control and Smart LS II light sensors. HF-ballast PCA EXCEL One4all or PCA ECO.



A retractable switch without indicator lamp must be used. On/off and dimming via the switch takes over control from the Smart LS II sensor. Smart LS II can only be connected to a Tridonic HF-ballast. Default setting of the required daylight value adjusted on the sensor. The value can be changed via the switch. The same phase must be used for control and feeding the HF-ballast. Neutral to the terminal block DA/D1 can be looped internally in the luminaire. If several HF-ballasts or more advanced control is required, please contact your Fagerhult representative.

switchDIM control with on/off function over occupancy detector



The occupancy detector switches off the light after the last occupancy and a time delay. The light is switched on at the last level, which can be off if the light was switched off manually. A retractable switch without indicator lamp must be used. Maximum 25 HF-ballasts can be connected to one control. The same phase must be used for control and feeding the HF-ballast. If several HF-ballasts or more advanced control is required, please contact your Fagerhult representative.

For more information go to www.barbourproductsearch.info

Premises without natural daylight usually need the lighting to be switched on continuously. However, in some cases some of the luminaires can be switched off when no one is in the room. Light control is ideal for corridors where the sufficient basic light can be quickly increased during occupancy. Energy savings can be up to 80 %.

Advantages:

- Luminaires with Tridonic PCA ECO or Excel one4all.
- E-Sense luminaire with smartSwitch sensors can be used.
- HF ballasts learn the automatic function the first time it is used.
- External standard occupancy sensors can be combined in the system.

Proposal for the installation of control in the corridor

Lighting is usually continuously lit in corridors where people normally move around. Examples are hospital culverts and corridors in large building complexes. Many installations have been made more energy efficient by detecting occupancy and the movements of individuals and with that switching on the lighting when necessary. The negative effect of this type of control is when you approach a darkened room the reaction time of the sensor is then decisive for how quickly the lighting is switched on. The combination of poor detection with the slow starting of the fluorescent lamp creates a scenario where the user enters the corridor before the lighting is switched on. Creating a feeling of displeasure and uncertainty. This can also have a negative effect on the life of the fluorescent lamp. Short ignition times result in lamp end blackening and a reduced life span.

If you know the lighting should always be on you can ensure that the lighting is on at a high level with occupancy and then reduced to a low energy-saving level awaiting the next detection. By regulating between high and low levels the cathodes are not consumed and the life span of the fluorescent lamp is not negatively affected.

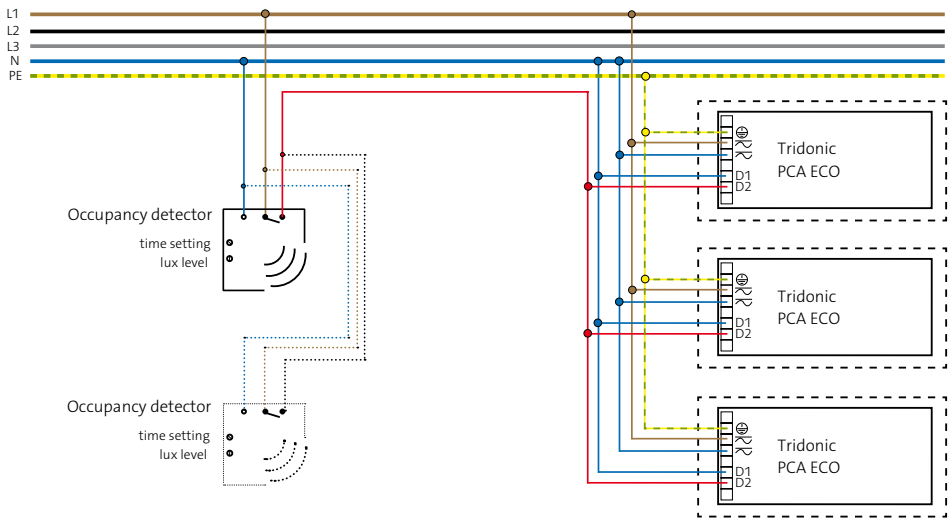
Light control in stairwells, corridors. The combination of smartSwitch sensors in the luminaires and external occupancy detectors means that detection will be complete.

Absence dampening time delays can be as short as one minute to regulate back to a low level.

The advantage of this type of control is that a central control unit is not necessary. Occupancy detectors are connected directly to the control input on the HF-ballast. After an on-pulse (occupancy) of 5 minutes the HF-ballast has changed function to adjust between 100 % with occupancy (230 V on the control input), and 10 % light with absenteeism. If you know that the room/corridor will not be used during certain parts of the day, for example in schools, you can switch off the lighting completely with the help of central control. See the wiring diagram below.

Product	
Indigo Clivus with Tridonic PCA ECO-lp HF-ballast	**24484-300**
Indigo Clivus with Tridonic e-Sense smartSwitch	**24484-309**
External occupancy detector (see opposite page)	

Absence dimming with Occupancy detectors and HF-ballast PCA ECO-lp



Connection for automatic control between 100 % (occupancy) and 10 % (absenteeism). The HF ballast PCA ECO-lp recognises that these properties are required and adjusts the standard switchDIM function automatically. The time can then be shortened on the occupancy detectors to give maximum functionality. Luminaires equipped with e-Sense smartSwitch can be used in combination with external occupancy detectors.

If luminaires with compact fluorescent lamps are used, the luminaires should be equipped with PCA EXCEL One4all HF-ballasts. The same phase to luminaires and sensors. A large number of luminaires can be controlled simultaneously as there is no output via the relay function. Switching can be controlled centrally, for example via a time switch.

For more information go to www.barbourproductsearch.info

Novum Compact Passage

Steinel PIR IS3180

CP Electronic
MWS-1/C
MWS-1 for corridors

Sensor Novum		
Component		
Sensor Compact Passage		**86225**
Flush wall box		**86226**
Protective guard (not used in combination with flush wall box)		**86227**

Sensor Steinel		
Component		
Sensor PIR IS3180		**86235**
Protective guard		**86227**

Sensor CP Electronic		
Component		
Sensor MWS-1/C	Sensor for ceiling mounting, detection 10x10 m.	**86230**
Sensor MWS-1	Sensor for corridors, wall mounting, detection 30x4 m	**86231**
Mounting frame		**86232**

Novum Compact Passage
PIR occupancy detector for lighting control. Designed for ceiling mounting, recessed in a pattress or surface mounted in a flush wall box. The detection range of this sensor makes it particularly suitable for corridors, though it can also be used in other environments. A separate input allows the lighting connector to be controlled manually via a pushbutton or switch. The occupancy detector is equipped with a 10–1500 lx light relay, while the output is designed to suit HF-ballasts, with current limitation to prevent high start-up currents. The Off delay can be set from 10 seconds to 20 minutes and also features a self-teaching function.
- Occupancy detection
- Long, narrow detection area
- On and Off delay
- Light sensor 10–1500 lx
- Pushbutton input

Steinel PIR IS3180
The IS3180 is a PIR occupancy detector for wall mounting and detects moving people with a range of up to 20 metres in all directions. Surveillance angle 180° and can be used both indoors and outdoors, e.g. in garages, passageways, stairwells, sports halls and changing rooms.
- Detection range: Horizontal 180°, vertical 90°, 8–20 m max.
- Lux threshold setting: 2–2000 lx.
- Off delay: 5 sec.–15 min.

Encapsulation class: IP 54.

CP Electronic
MWS-1/C Sensor
Microwave sensor for external mounting on walls, especially for corridors. The sensitivity provides good detection of up to 30x4 m with the sensor placed at a height of 2.5 m. No dead fields are formed. The unit is most easily fitted to a square frame, order no. 86232. No components are visible, which lends a discreet appearance to the unit.

The sensitivity and time can be adjusted variably under the cover.

CP Electronic
MWS-1 Sensor for corridors
Microwave sensor for external mounting on walls, especially for corridors. The sensitivity provides good detection of up to 30x4 m with the sensor placed at a height of 2.5 m. No dead fields are formed. The unit is most easily fitted to a square frame, order no. 86232. No components are visible, which lends a discreet appearance to the unit.

The sensitivity and time can be adjusted variably under the cover.

For more information go to www.barbourproductsearch.info

The majority of dimmable HF-ballasts are designed in accordance with the standard EN 60929 including the control of HF-ballasts with 1–10 V direct voltage. The HF-ballast creates the requisite control current itself and in the simplest form a potentiometer (usually linear, about 47 k) is enough for control. Most manufacturers' potentiometer controls also include electronics.

The HF-ballast senses the voltage in the control circuit. The lower the voltage, the lower the lighting level. If the control circuit is left open, the luminaire lights at full strength in the same way as an non-controlled luminaire operates. If the circuit is closed the lighting level drops to the minimum value. The minimum level of luminous flux varies depending on the manufacturer, type and light source. Normal minimum levels for linear fluorescent lamps are 1–5 %, and 3–10 % for compact fluorescent lamps. Check which levels apply for the luminaire you are interested in.

Apart from the phase, neutral and protective conductors, two other control circuit wires are connected to the luminaire. The control wires can be placed in the same conduit as the mains voltage cable feeding the luminaire. Even if the control voltage is a maximum of 10 V the insulation on the control wires must conform to the demands for a heavy current installation. You must ensure the polarity is correct when connecting the control circuit as incorrect connection can mean the installation drops to its minimum state.

In addition to the control wires, the phase conductor should also be connected via the control unit or combined potentiometer/mains switch, as the luminaires can only be switched on and off via the mains voltage. It is important to remember this when planning the cabling, as changes to the installation may be difficult at a later stage.

The breaking capacity of the potentiometer's switch should be taken into consideration during installation. Even if the potentiometer is capable of regulating up to 50 HF-ballasts, the capacity of the switch is usually 5–10 luminaires depending on their load. Contactors are needed for greater loads.

Note

- When selecting the control system you should take the system's and luminaire's compatibility into consideration. Luminaires designed according to the standard EN 60929 feed the control circuits themselves, which not all analogue control units permit.
- There are special demands for running control cables in enclosures together with other high current cables.
- The polarity of the control circuit must be maintained throughout. Regulation does not work correctly if the polarity is crossed on any of the luminaires in a group.

Control units

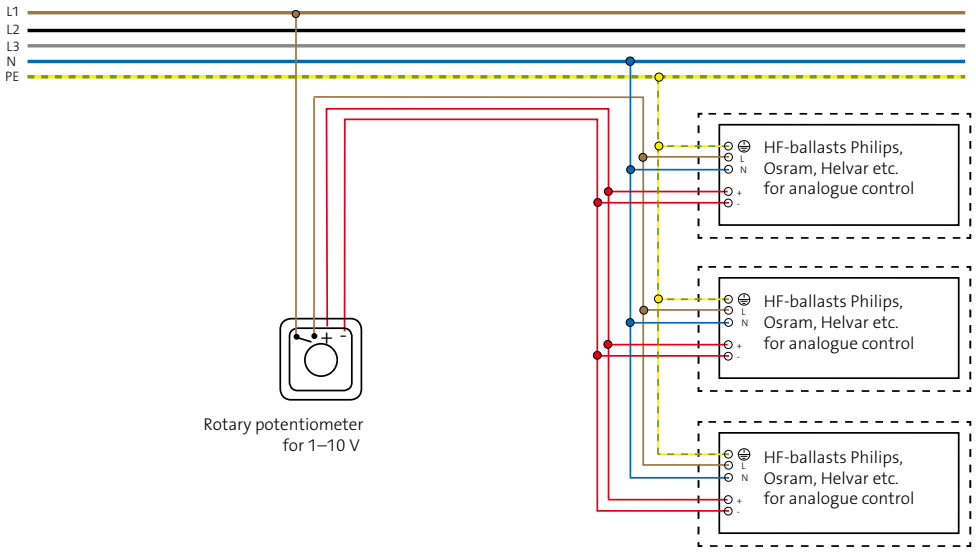
Component	Luminaire	Breaking capacity	
Ensto Busch-Jaeger 2112 recessed	50	4 A	**86080**
Ensto Busch-Jaeger 2112 surface mounted	50	4 A	**86081**

Ensto Busch-Jaeger 2112
Rotary potentiometer for recessed installation. Suitable for light control of a 1–10 V system. Integrated switch with breaking capacity 4 A (cosf > 0.9). Avoid igniting/extinguishing more than 4 luminaires. Additional contactors are needed when greater loads are ignited/extinguished. A maximum of 50 HF-ballasts can be controlled.

Ensto Busch-Jaeger 2112
As to the left, but with surface mounted installation box.

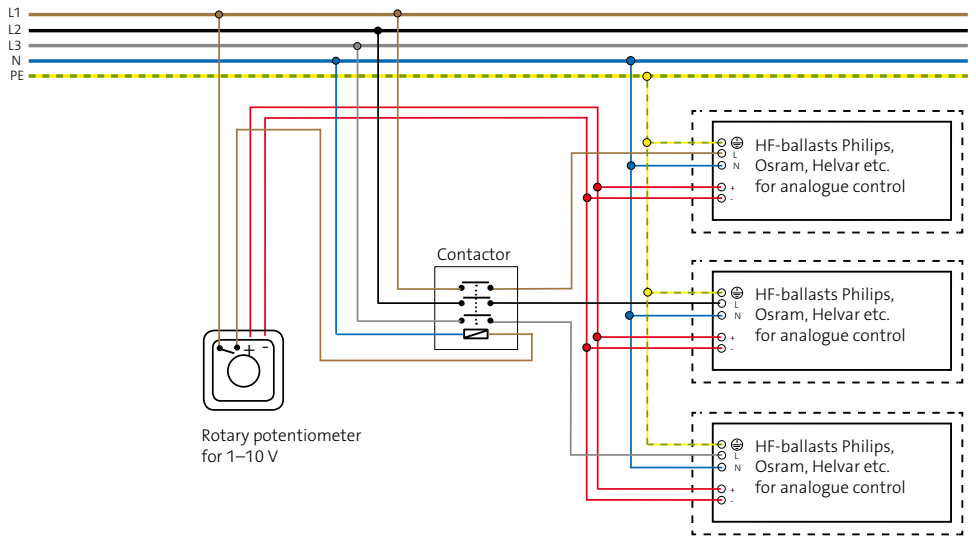
For more information go to www.barbourproductsearch.info

Analogue control for 1-phase installations



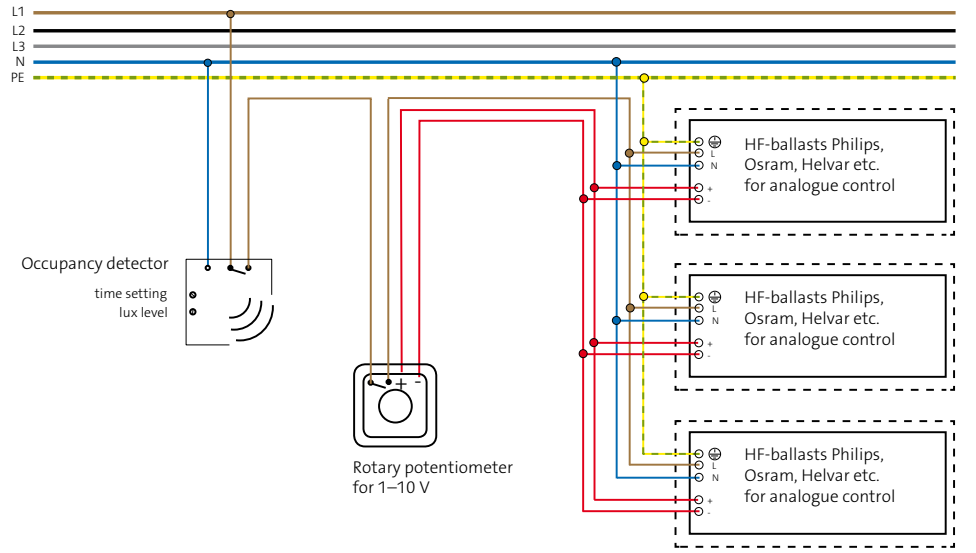
Do not mix HF-ballasts from different manufacturers or outputs. The control potentiometers can usually regulate 100 mA (approx. 50 HF-ballasts), yet have different breaking capacity on the switch function. Always check the data from the supplier.

Analogue control for 3-phase installations with contactor



Do not mix HF-ballasts from different manufacturers or outputs. The control potentiometer and control unit can usually adjust 100 mA (approx. 50 HF-ballasts) The same control signal can be connected to HF-ballasts independent of the feed phase with common switching over the contactor.

Analogue control for 1-phase installations with on/off function over occupancy detector



Occupancy detectors switch the lighting on and off depending on the occupancy. The potentiometer's switch function does not need to be used, if it is bypassed the light is always switched on to the set level with occupancy. Occupancy detectors from different manufacturers can be used. Always ensure that the sensitivity is good and that the relay function is dimensioned for the connected load. Setting of a lux level threshold can be used in premises with a great deal of daylight. The function prevents the lighting from being switched on when there is a lot of daylight.

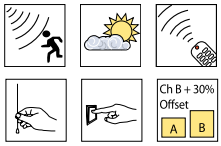
For more information go to www.barbourproductsearch.info

At Fagerhult we consider economy in lighting control to be the sum of all parts. Our e-Sense solution is easy to use and install, offering quality in both light treatment and ongoing energy efficiency. Fagerhults e-Sense luminaires are equipped with integrated light control; an attractive, easy installation without the need of add-on or external sensors.

No connections – no problems. Fagerhult e-Sense is the easiest, quickest way to install light control, insert the plug and the system is running. The luminaires have a newly developed multi-sensor that detects movement in the room, measures the incidental light and adapts the output accordingly.

Our aim has been to eliminate all the hidden costs of installation, operation and maintenance. To avoid switches and complicated settings. Install a luminaire and get a complete control system. Control the light yourself, with the help of a pull switch. Refurnish the office, the luminaire is a separate functioning unit. Timely and costly reprogramming is no longer necessary.

e-Sense ActiLume



ActiLume is a control system from Philips based on the DALI protocol. The system consists of a detector and a controller. The sensor has three different parts: a detector for presence, a sensor for daylight control and an IR receiver should you want to use a remote control.

e-Sense ActiLume offers maximum comfort and energy savings up to 75 %. The immense potential for energy savings offers the opportunity to make a rapid payback on the investment costs

The system also offers the user the chance to adjust the light to a personal level with the help of a retractable switch, pull switch or remote control.

ActiLume consists of a small, compact sensor unit and a controller designed for assembly in the luminaire. ActiLume is a simple system produced for "plug and play" lighting solutions in office milieus. The combination occupancy detector – light sensor – dimmable HF-ballasts gives a vast range of choices. With the experience of knowing which combinations are used the most, you can easily attain the perfect solution for light control in an office.

e-Sense ActiLume installed in the body of Ten° Line Lamell.

Start of ActiLume installation

To start an ActiLume installation is easy – insert the plug! ActiLume has a factory setting that automatically sets the lighting level, however, it should be adapted to reflect the lighting requirements for the room in which its installed. NOTE! Avoid the influence of daylight when doing this! Press the service button for more than 3 seconds (the fluorescent lamps flash once). After 30 seconds the adjustment is complete (the fluorescent lamp flashes again). The delay of 30 seconds is to permit the removal of objects, such a step ladders, which may interfere with the sensor recognising the work surface.

ActiLume adjusts the light level automatically to approximately 80 % of the new light value. This corresponds to about 600 lx (500 lx + 0.8 maintenance factor) on the work surface in an office with the normal placement of the luminaire. Adjustment to 80 % is as the new, maintained, light level is usually higher than the normal value. You already make savings with this setting.

You can easily choose one of two standard functions by pressing the sensor unit's service button (press for less than 3 seconds). When the button is released, the fluorescent lamps indicate by flashing once or twice:

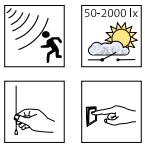
- One flash = "Mode 1" Office room (light switched off approx. 15 minutes after the last occupancy detection).
- Two flashes = "Mode 2" Open-plan office (light control adjusts down to a low level after the last occupancy and is switched off completely after 2 hours).

Manual control

A non-locking switch can be connected to the manual light control, quickly pressing for On/Off. Pressing and holding provides a dimmer function.

For more information go to www.barbourproductsearch.info

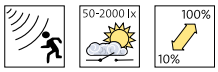
e-Sense smartSwitch



smartSwitch is an on/off-sensor that controls the connected luminaire via the mains voltage. There is also a model with pull dim for individual setting of the lighting level available. smartSwitch gives automatic ignition/extinguishing controlled by presence and the ambient light. The presence detection can be set with a delay of between 1 to 30 minutes.

When the amount of ambient light (daylight) is sufficient the lighting is switched off, the lighting level that activates switching off can be set between 50–2000 lx. This function can be omitted.

e-Sense smartSwitch absence dampening



A control function adapted to a room in an office which is used sparingly, for example, a copying room, stockroom, corridors or a cloakroom. The lighting level is set at a constant low level to counteract the impression of a darkened room. Any presence is detected and the lighting is adjusted to 100 %. The time delay to return to the low level (10 %) can be short unlike control with a switch off function where you need to avoid unnecessary starting of the fluorescent lamp. If you wish to switch off the luminaire completely, this can be done centrally once working hours are over. In addition, with the setting for lux on/off you can prevent control if there is already sufficient light in the room. Adjustment of the time and lux level are made on the rear of the sensor.

smartSwitch consists of a small sensor unit and the combined relay/power supply. The capacity of the relay is 200 VA, which means you can connect one or two HF-ballasts for ignition/extinguishing.

e-Sense smartSwitch placed in the louvre on a Closs Beta.

The sensor is a PIR-unit with a detection range of approx. 4x3 metres in a pendant luminaire. Within this area the sensor detects IR radiation from the body which is communicated to the relay, resulting in the luminaire switching on. The sensor unit has a lux level setting, a threshold value that prevents the sensor from reacting to occupancy if there is sufficient light in the room. This setting has been removed in luminaires with Dragdim, so that you can always manually switch on and switch off in a light room.

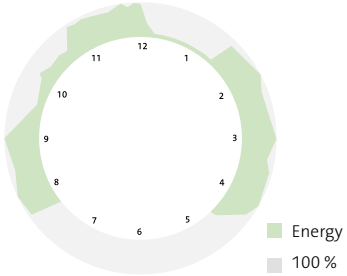
smartSwitch has been developed for various applications including cellular and open plan offices, entrances, corridors and small meeting rooms.

Fagerhults Loop Light luminaire can be retro-fitted with an end-cap inclusive of a smartSwitch sensor in an existing HF-std Loop Light; offering the ability to make savings via smartSwitch On/Off in a pre-installed system.

For more information go to www.barbourproductsearch.info

ActiLume offers maximal comfort and automatic energy saving. ActiLume adapts the level of light to the surrounding environment and when the room is not in use the light is switched off.

ActiLume offers maximum comfort and automatic energy saving. ActiLume adapts the level of light to the surrounding environment and when the room is not in use the light is switched off. When the sensor detects presence, the system automatically switches the light on. If there is sufficient daylight in a room the level is automatically dampened. The light is switched off when the room has been empty for some time. As light is only on when needed, the system can give the energy savings up to 75 %.



The images below demonstrate the different scenarios which occur during a working day, while the graph highlights the changes in energy consumption within this period.

Night: The office is in darkness.

07:45 am: The luminaire is switched on with presence as the daylight does not satisfy the lighting requirements.

Incidental daylight reduces the luminaire light accordingly, also known as daylight control.

Adjustment is performed slowly and constantly according to a set value. Uplight is set +30 % above the downlight.

Lunch: After the last presence is detected, the light is reduced and switched off after 15 minutes.

The luminaire is not ignited by presence as sufficient light is provided by incidental daylight.

Manual or automatic control to satisfy the lighting requirement.

After the last presence, the light is reduced and switched off after 15 minutes.

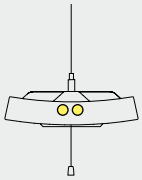
Occupancy detector
Presence control switches the lighting on and off automatically. After the last presence detection the lighting is switched off with a 15 minutes delay.

Daylight control
A sensor adapts the lighting output to the amount of incidental light (natural light). If there is no daylight, this function regulates the light output to maintain the required illumination level.

IR-receiver
To control and programme using the remote control if required. The remote control is an accessory.

Manual control (touch)
Full manual control via pull dim in the luminaire or retractive switch on the wall.

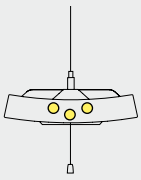
Channel B 30 % offset
Channel B has a 30 % offset, which means that channel B starts to be regulated when channel A drops to 70 %. When channel A is regulated to 10 %, channel B is then set to 40 %.



Pendant 2-lamp luminaire
Choices for occupancy detector:
- Automatic ON Automatic OFF (delay 15 minutes).
- Manual ON (with a light level over 600 lx) Automatic OFF (delay 15 minutes). (Always adjusts to low level before OFF).

Choices for daylight sensor:
- Automatic setting to 600 lx.
- Manual setting adjustment.

Choices for manual control:
- Dragdim or retractable switch on/off and control.
- IR-transmitter on/off and control (accessory).



Pendant 3-lamp luminaire
Choices for occupancy detector:
- Automatic ON Automatic OFF (delay 15 minutes).
- Manual ON (with a light level over 600 lx) Automatic OFF (delay 15 minutes). (Always adjusts to low level before OFF).

Choices for daylight sensor:
- Automatic setting to 600 lx.
- Manual setting adjustment.

Choices for manual control:
- Dragdim or retractable switch on/off and common control of downlight/ uplight.
- IR-transmitter on/off and control (accessory).

Special functions:
- 30 % Offset, uplight adjusted to 30 % above the downlight with dampening.

For more information go to www.barbourproductsearch.info

Combination manual/smartSwitch

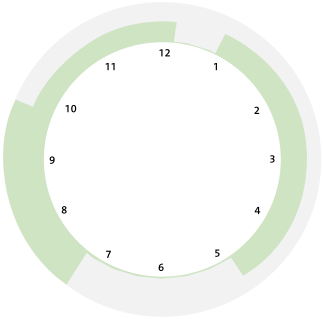
Night: The office is in darkness.

07:56 am: Automatic ignition.

Manual control of uplight and downlight.

The light is switched off according to the time set on the sensor, approximately 15 minutes.

The images to the left show a combination of manual control and occupancy detection. The graph demonstrates how the energy consumption varies throughout the course of the day.



smartSwitch with absence dampening

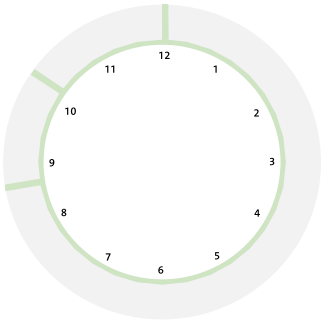
The light is set to a low basic level.

The light switches to a higher level when presence is detected.

The delay after the last occupancy is short, 1–30 minutes.

After the set time, the light is adjusted down to the basic level.

The images to the left demonstrates the different lighting scenarios which occur during a working day. The graph highlights how the energy use drops significantly when Absence dampening is used. Depending on the type of premises, it may be appropriate to switch off the lighting completely during the night using a time controller.



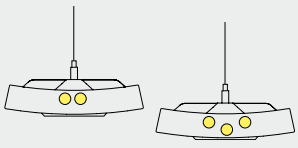
Occupancy detector
Presence control switches the lighting on and off. After the last presence detection the light is automatically switched off. The time between detection and switching off is adjustable, 1–30 minutes.

Lux level setting
Setting the threshold value prevents the occupancy detector reacting when daylight is sufficient.

Manual control
Manual control is only available in smartSwitch Dragdim luminaires.

Absence dampening
The occupancy detector adjusts to a high light level on detection and returns to a low level after a short period of time. No switch off function.

e-Sense smartSwitch On/Off
– luminaires without dimmable HF-ballasts



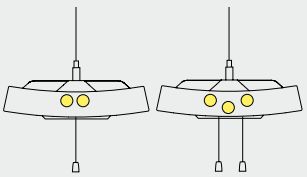
Choices for occupancy detector:
- Automatic ON/OFF (set time 1–30 minutes).
- Not ON (when the lux level is above the set value) Automatic OFF.

Choices for the Lux sensor:
- Not ON with high lux level.
- Manual modification of the lux level threshold (50–2000 lx).

Note:
- The luminaire does not have a dimmable HF-ballast, the function is only ON/OFF.

Fagerhults Loop Light luminaire can be retro-fitted with an end-cap inclusive of a smartSwitch sensor in an existing HF-std Loop Light; offering the ability to make savings via smartSwitch On/Off in a pre-installed system.

e-Sense smartSwitch
–pendant 2 and 3-lamp luminaire with dimmable HF-ballast



Choices for occupancy detector:
- Automatic ON/OFF (set time 1–30 minutes).

Choices for manual control 2-lamp luminaire:
- Pull cord ON/OFF and common control of the Downlight/Uplight.

Choices for manual control 3-lamp luminaire:
- Pull cord ON/OFF and control of the Downlight.
- Pull cord ON/OFF and control of the Uplight.

Special functions:
- The luminaire is equipped with an ECO-Ip HF-ballast with memory function when switched off.

Note:
- Do not use the lux level setting. If the room is light and the sensor does not ignite, the cord will not work.

e-Sense smartSwitch absence dampening
– luminaire with dimmable HF-ballast

Choices for occupancy detector:
- Automatic absence dampening 100–10 % (adjustable time 1–30 min).

Choices for the Lux sensor:
- Not ON with high lux level.
- Manual modification of the lux level threshold (50–2000 lx).

For more information go to www.barbourproductsearch.info

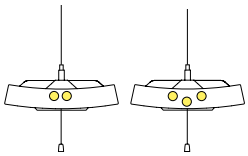
The investment in enhancing the lighting an office is a fraction of the costs of the actual personnel. Using lighting control you can create a visual stimulating working environment- while off-setting the costs with energy savings.

e-Sense luminaires are equipped with their own sensor helping to save installation time on-site.

Zora luminaires with integrated control for individual light above workplaces.

Advantages:

- Plug connection.
- Automatic switching on.
- Adjustment to a low level (20 %) after 15 minutes.
- Control with pull cord, no need for switches.
- Individual adjustment and on/off.
- Daylight control.
- Occupancy detector.
- Central switching after working hours.
- Easy programming with IR-transmitter.



Proposal for the installation of control in an office

The personal demands for light are as varied as the number of individuals at a workplace. With employees regularly leaving the office at different times light adjustments are requirement.

Using the effective e-Sense solution ActiLume in the luminaires, you get quick and easy installation and programming. Earlier attempts with individual occupancy detection created problems with extremely dark areas in the office after some personnel had left for the day, creating an uneasy feeling for those remaining. With the correct setting on ActiLume you get a constant basic light of 20 % on all luminaires at unoccupied workplaces.

Even luminaires that have been manually switched off drop down to 20 % light after 15 minutes, which creates a good light that saves energy and light sources.

Programming is easy using IR-transmitter IRT 86155. Central switching means that no energy is consumed in the form of standby power. Individual control with a pull switch means the cost of installing switches in modular walls is eliminated.

Product	
Zora Beta 2x35 W with integrated e-Sense ActiLume	**28700-308**

IRT 8010

IRT 8099

IRT 8050

LRM 8118

Accessories e-Sense ActiLume		
Designation	Function	
IRT 8010	Remote control with 2 buttons	**86153**
IRT 8050	Wall mounted remote control with 2 buttons	**86151**
IRT 8099	Remote control for programming	**86155**
LRM 8118	External occupancy detector	**86152**

IRT 8010 and IRT 8050
The units have only two buttons, one to switch on/increase the light level and one to switch off/reduce the light level. To adjust the light levels aim the transmitter towards the ActiLume sensor in the luminaire. The same control functions are offered by the transmitter IRT 8050 for fixed wall installation.

IRT 8099
Should you require a modified function, several modes can be programmed with the help of the remote control IRT 8099. The system comes with nine pre-programmed modes for e.g. schools, corridors, etc.

LRM 8118
If you wish to detect presence over a greater area, one or more detectors type LRM 8118 can be connected to one of the DALI terminals in the luminaire. No programming or commissioning is necessary. LRM 8118 is ideally placed in the ceiling, and has a detection area of approximately 7x7 metres. LRM 8118 is only an occupancy detector.

For more information go to www.barbourproductsearch.info

Recessed luminaires in are often selected in buildings with low ceiling heights or where there is a desire for an unbroken ceiling aesthetic. e-Sense ActiLume is a practical alternative to a switch by the door. Setting the daylight function and the occupancy detector is easy and can always be adjusted. Luminaires placed away from windows are controlled with a 30 % offset.

Advantages:

- Automatic switching on.
- Automatic switching off after 15 minutes.
- Offset 30 % for luminaires placed away from windows.
- Manual control if necessary.
- Daylight control.
- Occupancy detectors linked for a larger area.
- Easy programming with IR-transmitter.
- Connection using Wieland connectors as an option.

The combination sensors in the luminaire and external occupancy detectors ensures complete coverage in a large room.

Proposal for the installation of control in a large office

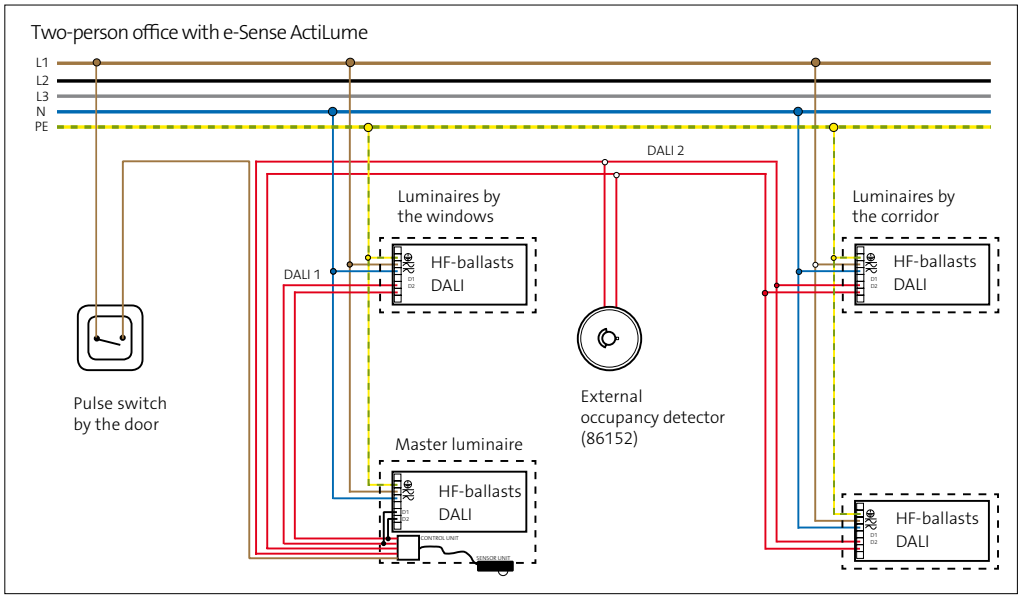
An effective lighting solution in large office can be achieved whereby an optimum level of light for working conditions is produced while additionally benefiting from energy savings.

Daylight control coordinates all the recessed luminaires, so that those positioned further in the room have an offset, that is 30 % higher than those closer to the windows and working area. With e-Sense ActiLume, luminaires by the window are assigned to channel 1 (window row) with further rows within the area assigned to channel 2 (inner placement in the room) ensuring that the depreciation of daylight in the room is compensated for.

This produces an adjustable, but even light over the entire room. For instance, when the window row is adjusted to 40 %, the inner rows will be at 70 %, i.e. a 30 % offset.

This function has previously been sought, but was practical impossible to achieve without an advanced bus system. Today it is pre-set with a master sensor placed in a luminaire. If the need arises, occupancy detection within the room can be expanded using extra sensors. Functions over and above the standard options can be programmed with IR-transmitter 86155.

Product	
MultiFive Basic Beta 3x14 W Master with integrated e-Sense ActiLume	**25483-308**
MultiFive Basic Beta 3x14 W DALI (max 10 connected to Master)	**25483-368**
External occupancy detector	**86152**



Installation in a two-person office with e-Sense ActiLume. The different control functions are connected to the master luminaire, which is placed in the row by the windows. Automatic switching on with occupancy. After the last detection the lighting is adjusted down to 20 %. After two hours the lighting is switched off completely. This setting can be easily changed to only a 15 minute delay by pressing the service button on the ActiLume sensor once.

Luminaires in the row by the corridor, furthest from the incidental daylight, are controlled via the DALI 2 lines, which has an offset of 30 % from DALI 1. This means that the luminaries furthest in the room give more light in the dimmed state. The size of the office room usually demands occupancy detection to be supplemented with en extra sensor which is placed centrally in the ceiling (86152). The lighting can be adjusted manually with a pulse switch by the door.

For more information go to www.barbourproductsearch.info

General lighting in the open-plan office can be made more effective if the installation is planned in advance and adapted to the daily activities, reacting to both occupancy and the level of incidental light in the space. Luminaires placed away from the windows are controlled with a 30 % offset. Low light level with absenteeism, but not switched off. This is effective control in an open-plan office.

Advantages:

- Automatic switching on.
- Automatic adjustment to 20 % after 15 minutes.
- Offset 30 % for luminaires placed further in the room.
- Manual control if necessary.
- Daylight control.
- Occupancy detectors linked for a larger area.
- Easy programming with IR-transmitter.

Indigo Combo Beta luminaires. The combination of ActiLume sensors in master luminaires and external occupancy detectors means that detection will be complete.

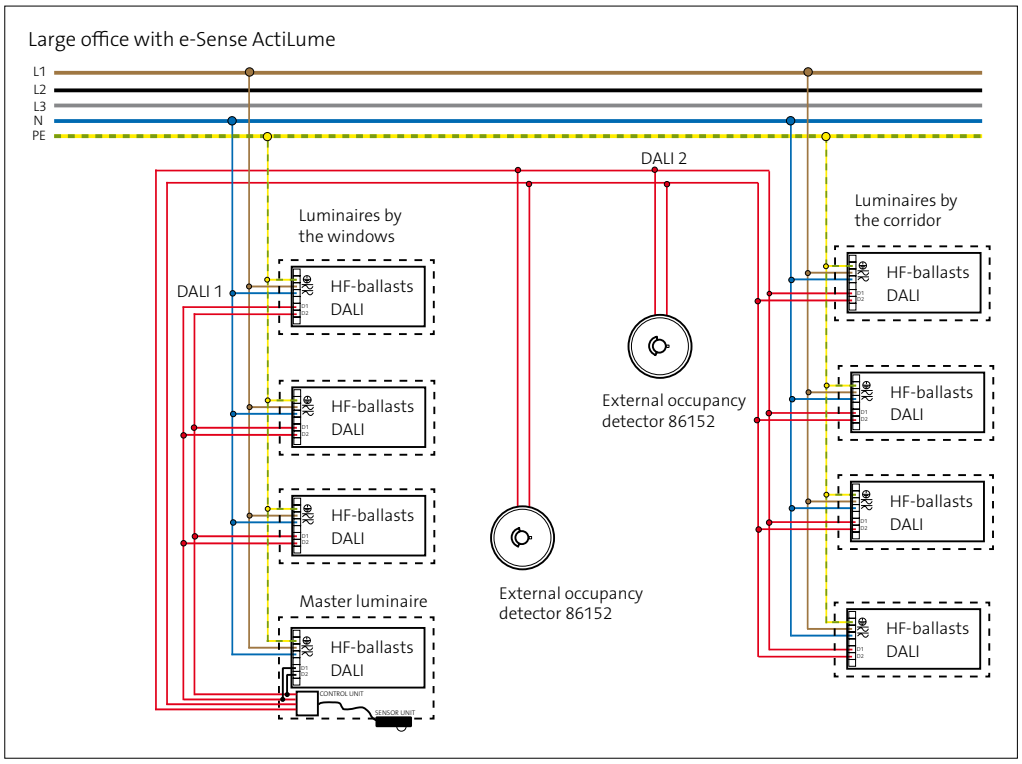
Proposal for the installation of control in a large office

General lighting for the open-plan office can easily be made more effective. Grouping the luminaires into zones based on location and window position, ensures you can get the right amount of light when working, and at the same time a solution that is in harmony with today's approach to energy. Daylight control becomes more effective and easier to manage if the detection and adjustment areas are not too different in size. Using an e-Sense ActiLume master luminaire placed in the window row and connected luminaires assigned to channel 1 (window row) and channel 2 (inner placement in the room) the depreciation of daylight in the room is compensated by a 30 % offset for the inner luminaires.

This gives an adjustable, but even light over the entire area. For example, if the window row is adjusted to 40 %, the inner rows are dimmed to 70 %, i.e. a 30 % offset. This function has previously been sought, but was practical impossible to achieve without an advanced bus system. Today it is pre-set with a master sensor placed in a luminaire.

The lighting zone can cover about 8 workplaces (depending on the furnishing) and 11 luminaires. Occupancy detection within the zone is expanded by extra occupancy detectors connected to the same control signal as the luminaires. Functions over and above the standard options can be programmed with IR-transmitter 86155.

Product	
Indigo Combo Beta 2x24 W Master with integrated e-Sense ActiLume	**24894-308**
Indigo Combo Beta 2x24 W DALI (max 10 connected to master)	**28894-368**
External occupancy detector	**86152**



Installation in an open-plan office with e-Sense ActiLume. The zone that one ActiLume system controls covers max. 11 luminaires, in this example eight luminaires. If the office is larger, parallel systems are installed that are adjusted individually. The different control functions are connected to the master luminaire, which is placed in the row by the window. Automatic switching on with occupancy. After the last detection the lighting is adjusted down to 20 %. After two hours the lighting is switched off completely. This setting can easily be changed with an IR-transmitter (86155) for programming.

Luminaires in the row by the corridor, furthest from the incidental daylight, are controlled via the DALI 2 line, which has an offset of 30 % from DALI 1. This means that the luminaries furthest in the room give more light in the dimmed state. The size of the office room usually demands occupancy detection to be supplemented with one or more extra sensors, which are placed centrally in the ceiling (86152).

For more information go to www.barbourproductsearch.info

Within a classroom environment e-Sense ActiLume offers many advantages. The lighting control is adapted to the size of the room, automatically incorporating the luminaires which are positioned away from the window. Installation costs are kept to a minimum thanks to the ease of installation and commissioning.

Advantages:

- Automatic switching on/off or only switching off.
- Daylight control.
- Offset control of luminaires by the corridor.
- Control by door and AV panels.
- Control integrated in standard pushbuttons.
- Quick programming using IR-transmitters.

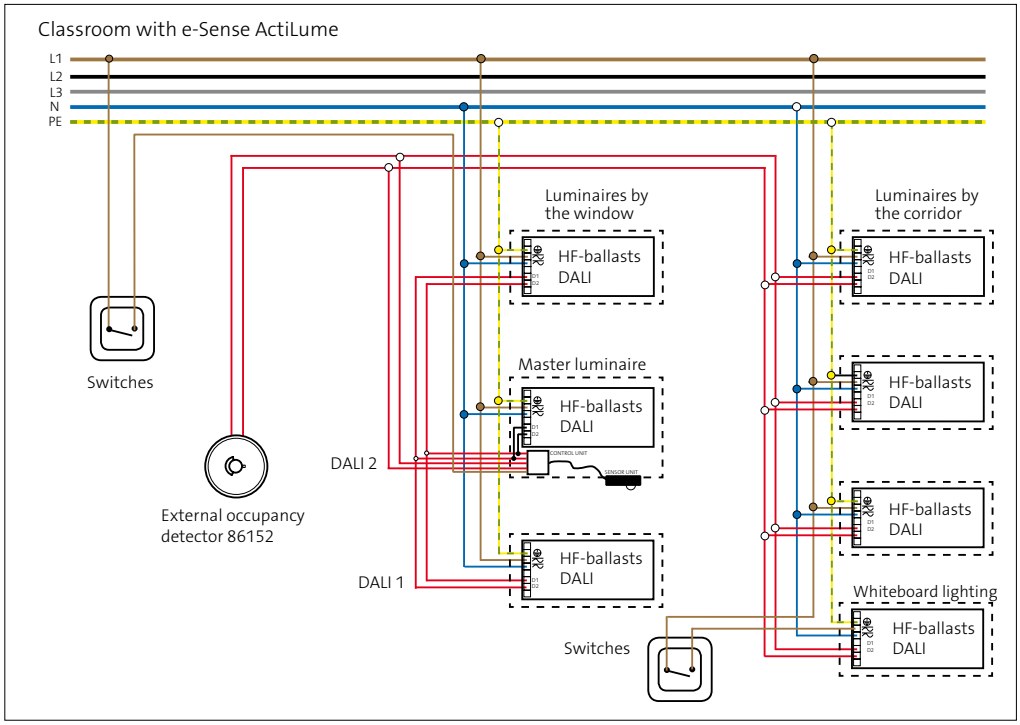
Proposal for the installation of control in classrooms

The sensor is pre-fitted in one of the luminaires in the row by the windows; acting as a master luminaire. The sensor offers occupancy detection and daylight control, which can be easily accessed via a IR-receiver and a service button. Other luminaires are connected to the master luminaire on two different DALI connections. The luminaires away from the windows are adjusted with an offset of 30 % compared to those located by the windows. The inclusion of offset control creates a balanced illumination over the whole area, which previously was only possible using an advanced bus system. After installation, a maintained illumination level of approximately 500 lx can be achieved by pressing the service button on the sensor and activating daylight control. The desired light level and other functions can be easily changed with an IR-transmitter 86155.

Depending on the design of an older installation, energy consumption can be reduced by up to 80 %.

Dimming gives the right light during lessons and saves energy.

Product	
Master luminaire Ten° Line Beta 2x35 W with ActiLume sensor	**26243-308**
Luminaire Ten° Line Beta 2x35 W DALI	**26243-368**
Luminaire Lento 2x1x35 W DALI	**19861-368**
External occupancy detector	**86152**



Installation in a classroom with e-Sense ActiLume. The different control functions are connected to the master luminaire, which is placed in the middle of the row by the windows. Luminaires in the row by the corridor, furthest from the incidental daylight, are controlled via the DALI 2 line, which has an offset of 30 % from DALI 1. Resulting in the luminaries furthest in the room providing more light in the dimmed state. The size of the classroom usually demands occupancy detection to be supplemented with en extra sensor which is placed centrally in the ceiling.

Ceiling lighting is controlled using the pulse switch by the door. The whiteboard lighting can also be switched off separately.

For more information go to www.barbourproductsearch.info

e-Sense ActiLume Connection Box

Quick connection system for controlling using e-Sense ActiLume

The e-Sense ActiLume Connection Box was designed particularly for use in lecture rooms, but equally lends itself to an office environment or rooms where the installation can be hidden above a suspended ceiling.

The installation and ongoing use of lighting solutions with control systems can often a complicated process. At an early stage a good understanding of the features of the control system is vital to avoid planning mistakes. Time can be needlessly wasted changing the installation, or simply starting again from the beginning.

As a control system, the e-Sense ActiLume is already prepared for simple deployment. Minimal effort is required to implement an installation on site, and changes can easily be made using an IR transmitter, or simply via a tip of a pen.

To aid the installation turning into a more modern, flexible and quick solution, there is a choice of luminaires ready for connection to a specially made connection box. With virtually everything already connected. Connect the power to the box and all luminaires can then be connected one at a time without needing to disconnect the power. This reduces the risk of mixing up the connections, facilitating a quick, safe installation. All functions can be connected or disconnected without risk.

For maintenance work, the power does not need to be disconnected. The luminaire can simply be disconnected from the box or splice connection. During maintenance work, the other luminaires in the room will remain lit to facilitate work. A luminaire can also be removed and maintenance work carried out elsewhere.
We have chosen the Wieland GST connection system as standard for this solution.

e-Sense ActiLume Connection box	
ActiLume Connection Box (complete)	**88220**
Wieland T-connector	**91026**
Wieland Connector cable, L= 3.0 m	**88222**
ActiLume 86152 External sensor	**86152**
IR transmitter for programming (IRT8099)	**86155**

e-Sense ActiLume Connection Box

Connection box prepared for connection of master and slave luminaires, etc. Connectors included for:
- Feed 230 V (black).
- Pulse switch (brown).
- Switch (brown).
- External occupancy detector (grey).
- Connection of board illumination (5-pole, blue).

Example of Master luminaire for connection to e-Sense ActiLume Connection Box DTI 28924-321
DTI Type 2 Beta 2x35 W, with e-Sense ActiLume sensor and complete cable rack, screened and halogen-free.

Example of Slave luminaire for connection to e-Sense ActiLume Connection Box DTI 28924-325
DTI Type 2 Beta 2x35 W, with complete cable rack, screened and halogen free.

The advantages of the e-Sense ActiLume Connection Box
- Luminaires complete with all cable racks – no knowledge required for connecting the parts.
- Quick connection in connection box – each function clearly marked.
- All connectors for external functions included with delivery – no knowledge required for ordering component parts.
- Comprehensive installation instructions included in the pack.
- The control system works immediately following power-up.
- Easy programming, either directly on the master luminaire or using the IR transmitter.

Control functions
- Occupancy detection with a choice of automatic or manual switch on.
- Adjustment for daylight according to pre-set level. Can easily be changed.
- Manual control via a momentary pushbutton for On/Off and adjustment.
- Switches off after 15 minutes or changes to a lower light level depending on the choice of “mode”.
- Offset function. Luminaires at greater distances from windows can be connected to a DALI 2 for 30 % offset. This means the light is regulated with an offset of 30 % from the setting on the master luminaire.

The system is supplied in factory setting modes 1 and 2. Program using IR transmitter 86155 for a choice of 7 additional “modes”.

For more information go to www.barbourproductsearch.info

e-Sense ActiLume Connection Box

Complete solution for lecture-rooms with suspended ceilings

Nowadays the need lighting layouts and controls in a lecture-room is well-defined and fully tested. Fagerhult has developed a standard solution for a standard lecture room comprising six or nine ceiling luminaires including luminaires above the whiteboard.

A complete solution, with e-Sense ActiLume as the control system, combines quick installation with unbeatable characteristics and advantages in regards to both use and maintenance. Control with occupancy, incidental daylight and manual control optimise energy savings, at the same time as providing an excellent lighting solution. The system can save up to 60–70 % energy compared with an older installation.

The e-Sense ActiLume Connection box is a quick, efficient and complete method to install a light controlled solution. Standard installation cable is only needed for the cable lengths that cannot be determined in advance: cables to the whiteboard lighting (5-core), pushbuttons by the door and by the whiteboard lighting (2-core), and for external occupancy detectors (2-core).

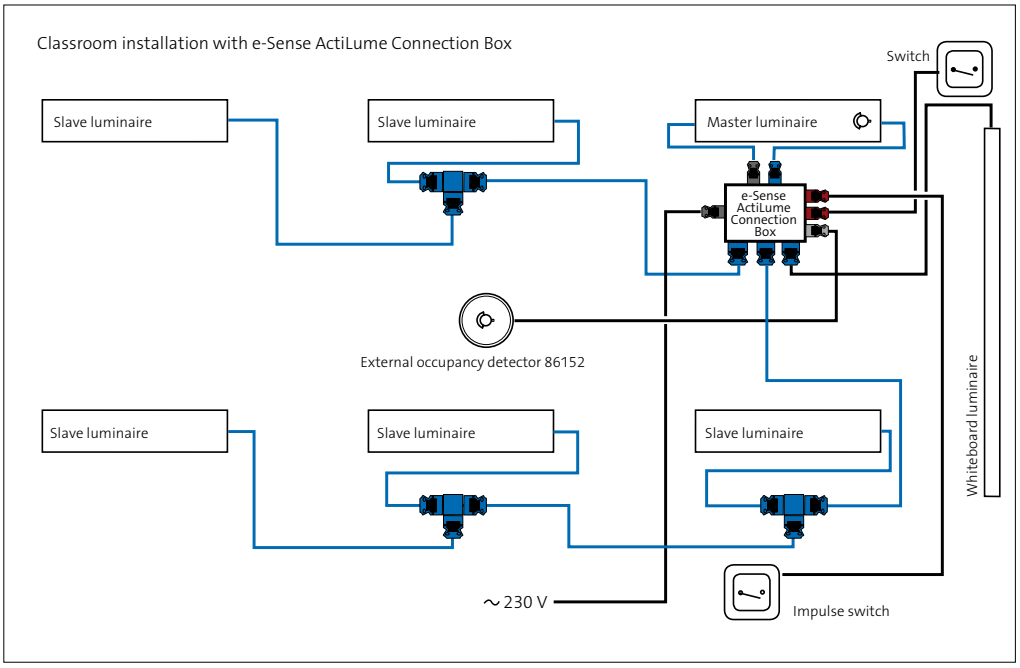
Advantages of the complete solution for lecture-rooms

- An order comprises a complete lighting solution with control for one lecture-room, with pendant luminaires and whiteboard lighting.
- Two different solutions are offered, one with six luminaires DTI for lecture-rooms 8x6 m, one with nine luminaires DTI for lecture rooms 9x7.5 m.
- Whiteboard lighting complete with DALI HF-ballast, Lento 1x35 W.
- Easy programming, either directly on the master luminaire or using the IR transmitter.

For more information please contact our customer services.

Complete lecture-room delivery	Lecture-room 1	Lecture-room 2
Lecture-room, number of ceiling luminaires	6	9
Connection box incl. all connectors that are necessary	1	1
Master luminaire DTI Type 2 Beta 2x35 W 28924-321, complete with mains cables, L=3.0 m[1)] and connectors, including fluorescent lamps and wire suspension.	1	1
Slave luminaire DTI Type 2 Beta 2x35 W 28924-325, complete with mains cables, L=3.0 m[1)] and 5 way connectors, including fluorescent lamps and wire suspension	5	8
Whiteboard Lento 1x35 W 19843-368, white, complete with dimmable HF-ballast (mains cable not included)	1	1
Cables for connections between luminaires, L=3 m	3	6
Connectors (T-connector)	3	6
External occupancy detector	1	1

[1)] All cables are screened and halogen free.



Example of an installation in a lecture-room with 6 ceiling luminaires. Connection box placed in the vicinity of the master luminaire. The remaining luminaires are connected on the two outputs: DALI 1 for dimming in line with the master luminaire, DALI 2 for dimming with 30 % offset.

The cables (5) marked in black are standard wiring cables where the length cannot be defined in advance and are not included in the delivery. Connectors to the box are included.

For more information go to www.barbourproductsearch.info

Lighting can be made more efficient with energy savings in many areas within office environments. The light in stores, filing rooms and stationery rooms is nearly always switched on continuously irrespective of whether there is someone in the room or not. Now you can easily install effective light control with large potential for savings.

Advantages:

- Plug connection.
- Automatic switching on.
- Adjustment to a low level (10 %) after a chosen time, adjustable 1–30 minutes.
- Occupancy detectors integrated in the luminaire.
- Centralised switching after hours optimises savings.

Proposals for the installation of controls in stores

Lighting in offices represents 30–40 % of the energy consumption. This comprises not only of the lighting load, but mainly the additional load required to counteract the additional heat produced. The cooling requirement is great for approximately nine months of the year. If you can avoid using the installed supplementary cooling you will save a great deal of energy. With a new approach you can make virtually all premises energy efficient. The effective use of lighting in office ancillary areas can be as low as 5 %. The lighting is usually left on constantly out of habit rather than necessity.

Using a luminaire with e-Sense smartSwitch for absence dampening can offer energy savings of up to 80 %. No external sensors or switches are required. The luminaire ignites quickly to 100 % with occupancy and adjusts down to 10 % after the set time. The time delay after occupancy can be as short as 1 minute, which optimises savings. As the light is not switched off completely, it can be switched on as much as you like without affecting the fluorescent lamp's cathodes and with that its life.

smartSwitch absence dampening results in significant energy savings in rooms that are seldom used or used only briefly.

Product	
Ten° Line Lamell with integrated e-Sense smartSwitch absence dampening	**26128-218**

For more information go to www.barbourproductsearch.info

Fagerhult offers luminaires with some unique functions. A sensor based on microwave technology can be hidden in the luminaire without affecting its design or insulation class. Fagerhult offers a selection of luminaires with this technology to suit various areas of application and needs.

The table shows how the properties of a microwave sensor differ from those of a normal PIR (Passive Infra-Red) sensor. A microwave sensor can detect movement on the other side of a thin wall, such as one made of plaster. This function is particularly beneficial in areas such as WC's, whereby the light be switched on prior to the door being opened. The sensitivity (or the detection range), however, can be reduced to avoid erroneous detection.

A microwave sensor should not be placed close to ventilation outlets or large metal surfaces as this may cause the sensor to detect movement constantly. The settings for sensitivity, time after last movement and lux threshold are adjusted in fixed steps on the sensor module. The relay output can be loaded differently, depending on whether you are switching on/off one or more luminaires, or using the relay to adjust the lighting between various levels, referred to as absence dimming or corridor function.

How does a microwave sensor work?

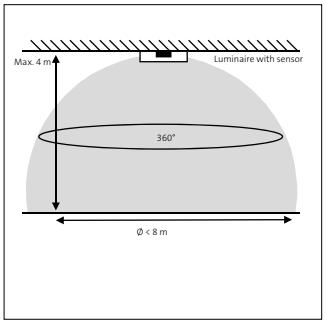
Like a radar, the sensor sends out a signal with a power rating of less than 10 mW, which is then reflected back. When the time of the reflected signal changes, the sensor detects a movement. The power of a sensor is around a hundredth of that emitted by a mobile phone.

Comparison between sensors

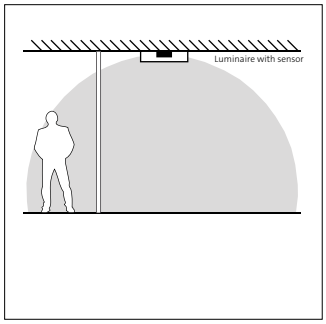
Function/property	Microwave sensor	PIR sensor
Hidden in luminaire	Yes	No
Detects infra-red heat in motion	No	Yes
Detects objects in motion	Yes	No
Can be placed in a suspended luminaire	No	Yes
Detects through walls/glass	Yes	No
Adjustable detection range	Yes	No [1]
Relay output	Yes	Yes
Adjustable Off time	Yes	Yes
Adjustable lux threshold	Yes [2]	Yes
On/Off function	Yes	Yes
Absence dimming function	Yes	Yes
Slave connection	Yes	Yes

[1] The detection range of a PIR sensor can be reduced by partially covering the lens with tape, for example.

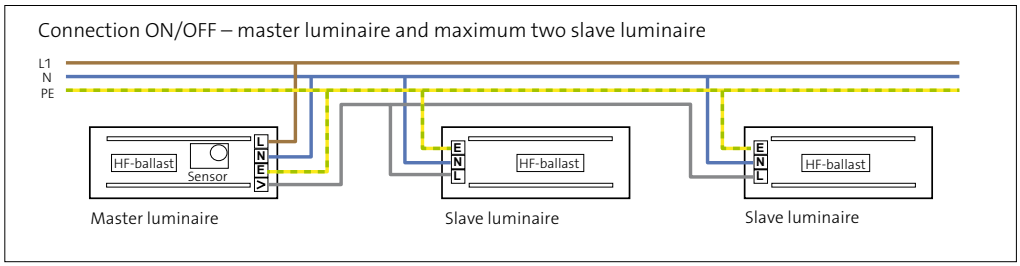
[2] Lux threshold can be used when the light of the luminaire is not directly reflected into the photocell. This happens in luminaries with an opal diffuser, so the use of a lux threshold is not recommended with microwave sensors placed in luminaires.



Ceiling mounting with max. sensitivity. Sensitivity can be adjusted in fixed steps of 20, 30, 50, 75 and 100 %.



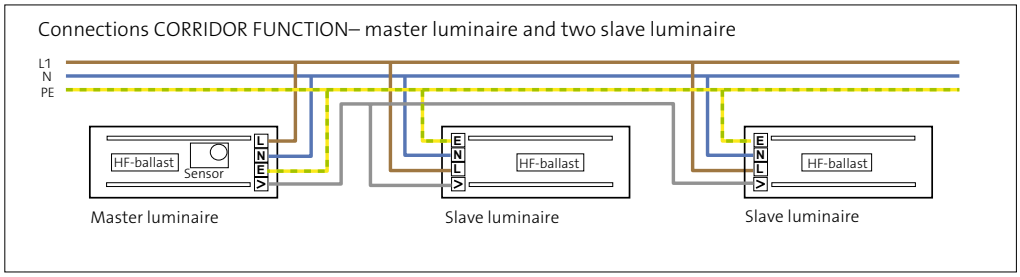
NOTE! A microwave sensor can detect movement on the other side of a thin wall.



The luminaires are equipped with standard HF-ballasts for On/Off. The master and slave luminaires switch off after the last movement and once the delay has expired.

Due to the properties of the sensor's relay, only two luminaires (two HF-ballasts) can be connected as slaves. It makes no difference if a number of sensor luminaires are connected in parallel in the same function. The master luminaire is connected with 4-core and the slave luminaires with 3-core.

The Discovery with microwave sensor.



Along with the Tridonics HF-ballast, the relay in the microwave sensor can be used for a corridor function. Instead of disconnecting the power to the HF-ballast, a control cable is connected to the relay output of the sensor, thus regulating the light. The relay is closed by someone's presence and provides full lighting immediately. After the last detected presence and the expiry of the delay, the light is slowly adjusted down to 10 %.

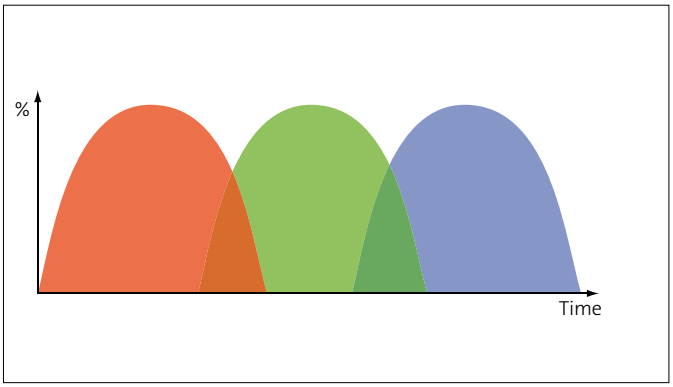
As the relay is not loaded with any power, a larger number of luminaires can be connected to the same control. Additional master luminaires can be added to the installation. The installation can only be done as a 1-phase installation. Certain luminaires with sensors and connections for corridor function can only be used at 75 % sensitivity due to interference between the frequency of the fluorescent lamps and the sensor. The master luminaire and slave luminaires are connected with 4-core. The HF-ballast is the Tridonic Excel One4all or the ECO-lp T5 (for compact fluorescent lamps, only the One4all is suitable). In special cases, the One4all ballast can also be programmed for other functions.

For more information go to www.barbourproductsearch.info

Luminaires with automatic or programmable control

LEDs are available as light sources in various colours. The first, and most usual, colour of an LED is red. It is normally combined with green and blue, and in special cases also yellow (to create a warmer, white light). The term RGB control is normally used for LEDs in the colours red, green and blue. By mixing and combining the three colours in various strengths, it is possible to create around 65,000 different colours. To create your own colours, some form of control unit or interface is required to a piece of software that communicates via DALI or DMX512.

A luminaire such as Pozzo with RGB control and a DALI interface is also supplied with automatic sequence control. When the power is connected to the luminaire's LED module, the sequence starts immediately. Pozzo has separate connections for fluorescent lamps and LEDs. Using two switches, this allows you to choose between normal fluorescent lighting or RGB control. If the fluorescent lamp is switched on, the different light intensity means the RGB control is barely noticeable. If a number of luminaires with automatic sequence control are located in the same room, after a while you will notice a difference between the various sequences as the colours will be out of step when changing.



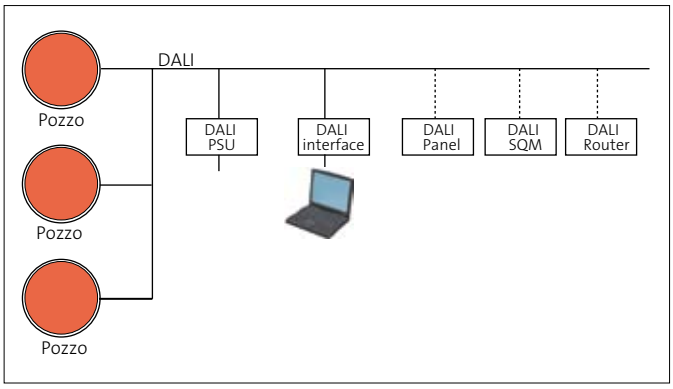
Example of automatic RGB sequence.

Programmable RGB control

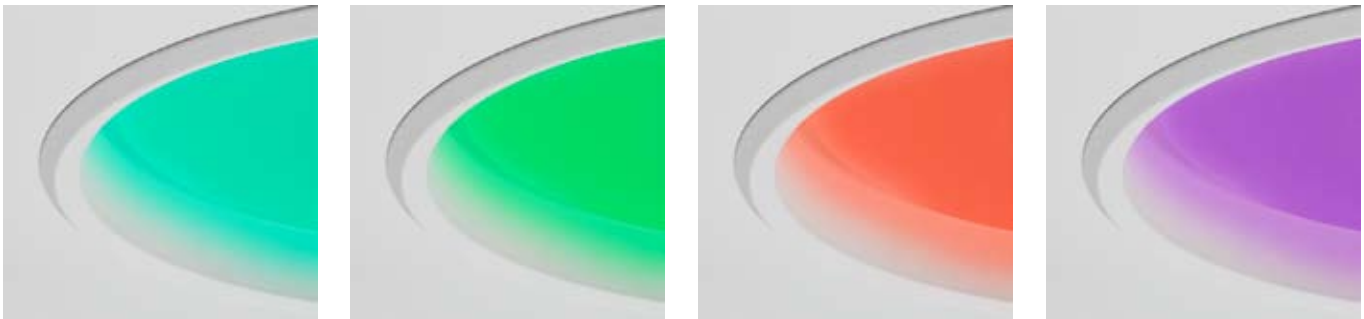
If the interface module in the Pozzo is connected to a DALI system with an external power supply and software, the automatic sequence control will cease. The three channels for red, green and blue will then function as standard DALI loads.

Each colour will become a DALI address, so 10 RGB controls will acquire 30 DALI addresses. Control can be handled in different ways. A DALI SQM can control all units if you wish to continue with automatic sequence control.

For manual control in fixed scenes after programming, a push-button panel can be used, for example a DALI Touch panel with 4 scenes and Off function. For advanced control, a DALI router can be used to control all imaginable functions.



A PC, with the required software, is used for programming.

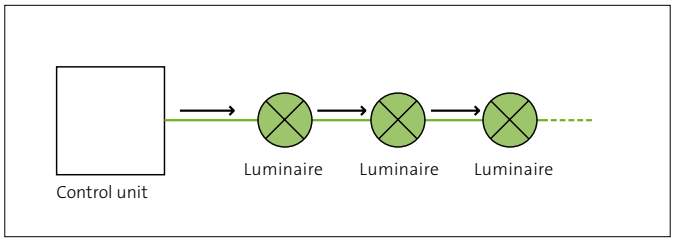


When an RGB luminaire is powered up, the colour changes of the sequence control start automatically. If a particular colour is required, the luminaire or luminaires in a room can be programmed to show the desired colour or all change simultaneously. It is also possible to create various light scenes selected using a panel.

For more information go to www.barbourproductsearch.info

DMX512 is a standard protocol developed for controlling lighting and dimmers from a lighting board in theatre environments. As it has a high transmission speed, it places certain demands on installation and the choice of cables and connectors.

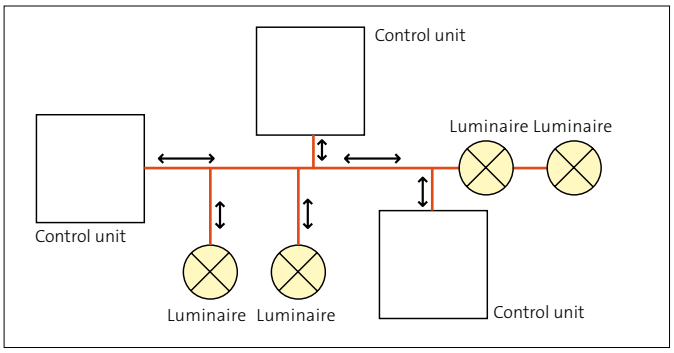
DMX control has now found applications in other environments due to developments in light sources and requirements for coloured lighting in outdoor applications etc. DMX, RGB and LED are often considered equivalent. Put simply, DMX uses a control unit to control all the loads.



DMX is a centralised control system.

DMX compared with DALI

Comparing DMX with DALI reveals more differences than similarities. The development of DALI focused on energy-efficient fluorescent tube lighting in public environments where people stay and work. The impact of DALI has been enormous despite this limitation, but its simplicity was the decisive factor. Multiple control units can control all or parts of the loads.



DALI is a decentralised control system.

DALI/DMX comparison

Control protocols	DALI	DMX
Speed	Slow	Fast
Number of addresses	64	512
Multiple devices with the same address	No [1]	Yes
Automatic addressing	Yes	No [2]
Centralised control	No	Yes
Decentralised control	Yes	No
Cable length	300 m	300 m
Cable requirement	No	Yes, Cat-5
End-of-line resistor	No	Yes

[1] *Converters for 1-10 V are common.*
[2] *RDM luminaires can be addressed using software.*

Colour Chaser Touch.

ToBeTouched RGB.

ToBeTouched White.

DMX is under development

DMX is also available in a recently updated version, RDM, that enables loads to be addressed using DMX cable and software. This requires the loads and the software to be correctly selected. The most common method of DMX addressing uses DIP switches on each device.

Installations

DMX is highly suitable for use in fixed installations using standard network cables normally used for computers. DMX cables and connectors used to be made for theatre applications, with far too many variations and an unnecessarily robust design. Fagerhult prefers to use Cat-5 connectors and we recommend cables of the same standard.

Basic rules for installation

When installing it is important to follow the recommendations for a reliable system.

- Use Cat-5 or better network cables.
- Always connect cables from device to device.
- Never create branches or closed loops.
- Never finish with an unused cable loop.
- Loads greater than 20 in number need to be distributed using a multiplexer (distribution device).

Daisy chain

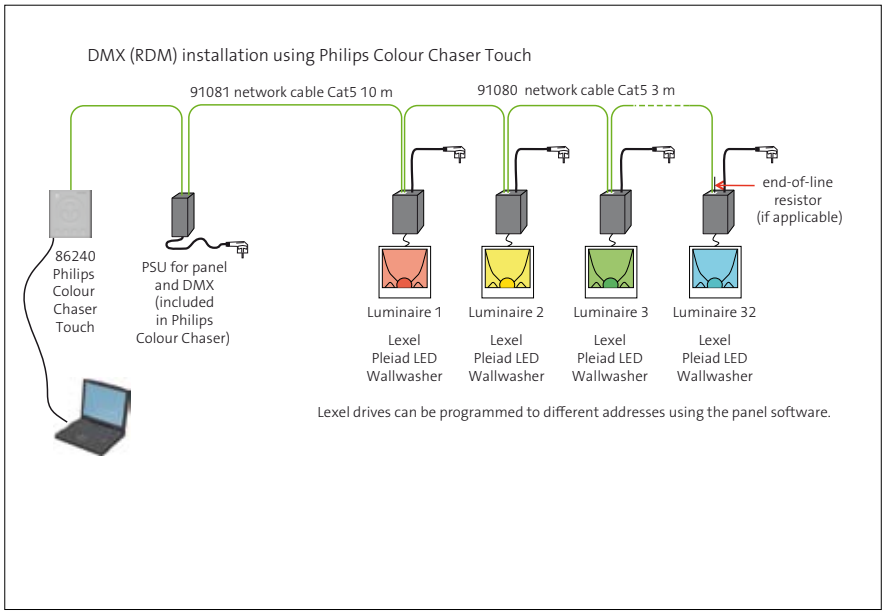
The technical expression 'daisy chain' describes a method of connecting devices in series (although in fact all devices are connected in parallel). This applies in particular to DMX. To simplify installation, and make it easier to connect further devices, Fagerhult use two connectors in some luminaires, such as the Pleiad LED wallwasher.

Large installations also require the loop to be balanced using an end-of-line resistor in the luminaire furthest from the control unit. If in doubt, contact Fagerhult for information on how to proceed with a system.

DMX-components

Control panels		
Philips Colour Chaser Touch	Control panel incl. PSU	**86240**
Philips ToBeTouched RGB	RGB control panel	**86241**
Philips ToBeTouched White	Colour-temperature-change control panel	**86242**
Power supply unit		
PSU	Power supply for ToBeTouched panels. 1 per panel	**86243**
Cat-5 network cable		
Network cable	3 m	**91080**
Network cable	10 m	**91081**

For more information go to www.barbourproductsearch.info


DMX (RDM) installation using Philips Colour Chaser Touch
91081 network cable Cat5 10 m
91080 network cable Cat5 3 m
end-of-line resistor (if applicable)
86240 Philips Colour Chaser Touch
PSU for panel and DMX (included in Philips Colour Chaser)
Luminaire 1
Luminaire 2
Luminaire 3
Luminaire 32
Lexel Pleiad LED Wallwasher
Lexel drives can be programmed to different addresses using the panel software.

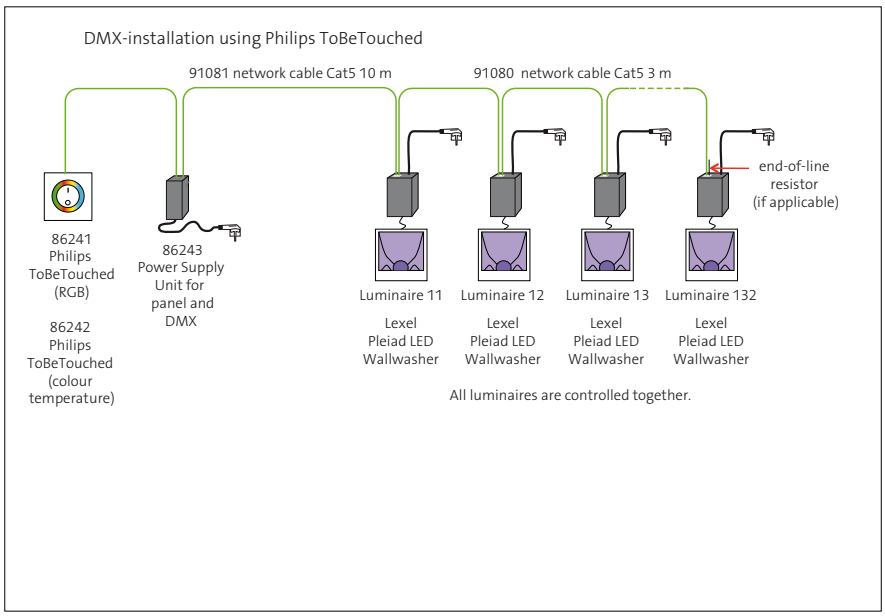
DMX control using the Philips Colour Chaser Touch provides many possibilities for personalised programming of light functions.

The panel can be mounted over a standard pattress or directly onto a wall. Power supply units could be placed e.g. above a suspended ceiling.

Installation is simple. Use ordinary network cables between the control panel and the loads. Connect each light source or drive unit to a 230 V power supply. Luminaires using DIP-switch addressing can be combined with luminaires using RDM addressing (via software).

Colour Chaser Touch 86240:

- *Touch button for TO/FROM.*
- *Four saveable presets/light scenes.*
- *Manual adjustment of colour (C), intensity (I) and saturation (S).*
- *Software for advanced lighting setup – RDM addressing of light sources*
  - *Simple composition of light sequences using large number of preset colour themes.*
  - *Colour setup can be sampled from images.*
  - *The Colour Chaser Touch panel can be connected to a computer via USB.*


DMX-installation using Philips ToBeTouched
91081 network cable Cat5 10 m
91080 network cable Cat5 3 m
end-of-line resistor (if applicable)
86241 Philips ToBeTouched (RGB)
86242 Philips ToBeTouched (colour temperature)
86243 Power Supply Unit for panel and DMX
Luminaire 11
Luminaire 12
Luminaire 13
Luminaire 132
Lexel Pleiad LED Wallwasher
All luminaires are controlled together.

Philips ToBeTouched is an easy-to-use panel for setting light and colour. The panel's intuitive design makes the functions simple to understand, enabling the desired light and colour settings to be made.

The panel can be mounted over a standard pattress or directly onto a wall. Power supply units could be placed e.g. above a suspended ceiling.

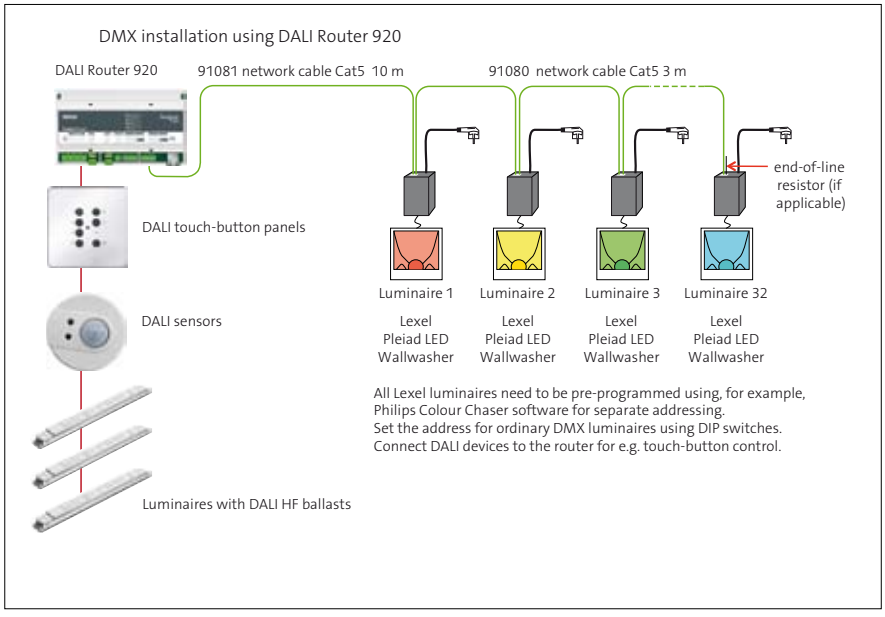
Installation is simple. Use ordinary network cables between the control panel and the loads. Connect each light source or drive unit to a 230 V power supply. Luminaires using DIP-switch addressing can be combined with luminaires using RDM addressing. All devices will be adjusted at the same time.

ToBeTouched 86241 (for full colour control):

- *Touch button for TO/FROM.*
- *Two saveable presets.*
- *Manual adjustment of colour (C), intensity (I) and saturation (S).*

ToBeTouched 86242 (for colour-temperature control):

- *Touch button for TO/FROM.*
- *Two saveable presets.*
- *Manual adjustment of colour temperature between 2500 and 6500 K.*

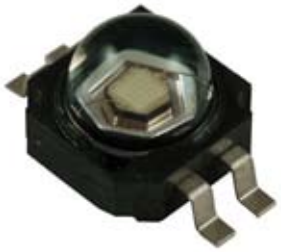

DMX installation using DALI Router 920
DALI Router 920
91081 network cable Cat5 10 m
91080 network cable Cat5 3 m
end-of-line resistor (if applicable)
DALI touch-button panels
DALI sensors
Luminaires with DALI HF ballasts
Luminaire 1
Luminaire 2
Luminaire 3
Luminaire 32
Lexel Pleiad LED Wallwasher
All Lexel luminaires need to be pre-programmed using, for example, Philips Colour Chaser software for separate addressing.
Set the address for ordinary DMX luminaires using DIP switches.
Connect DALI devices to the router for e.g. touch-button control.

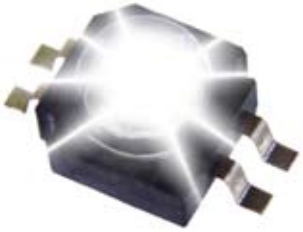
Control using the Helvar 920 Router. This device has a connection for DMX control of loads, which can be combined with DALI control. This enables advanced RGB control using DMX to be integrated with ordinary fluorescent tube loads and control functions. DMX control is normally limited to a single control unit, but this solution enables all the lighting to be controlled in a more energy-efficient and user-friendly manner.

- *Manual adjustment using touch buttons.*
- *Sensors for on/off etc.*
- *Full calendar control. The light can be programmed in detail according to almanac forecasts and event calendars.*
- *Flexible solution for light sources.*

For more information go to www.barbourproductsearch.info

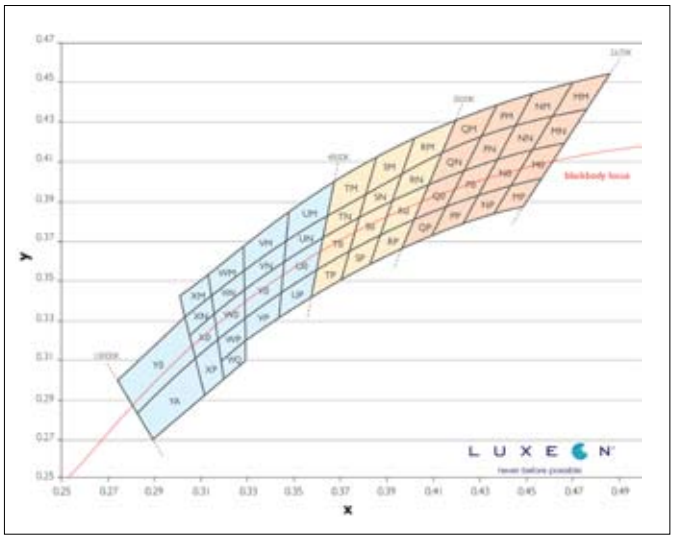
LED is an abbreviation of Light Emitting Diode. LED is a semi-conductor which when electrically stimulated emits light (also called electroluminescence). The light colour emitted is dependent on the materials used during manufacture. The basic colours manufactured are red, orange, green and blue. White light is produced by mixing the three different colours: red, green and blue (RGB) or, which is more common, a blue LED equipped with a luminescent material that converts the emission to yellow light. The sum total is white light.





Binning

An outcome of LED production is a large variation of both colour temperatures and luminous flux. The variations are so great that it is absolutely essential to select a limited assortment. This method of selection is called binning. Manufacturers divide up the LEDs after production into different groups depending on performance. The narrower the selection process, i.e. only accepting LEDs from a single bin, results in a higher product quality. Disadvantages are that the price can increase while availability decreases. Consequently, attempts are made to choose LEDs from a number of neighbouring bins.



Example of different bins, in this case from Philips Lumileds.

White LEDs

White LEDs are available in warm, neutral white as well as cold colour temperatures (2700–8000 K). Colour reproduction (Ra) can vary, depending on the choice of LEDs, from 70 to approximately 90. An LED with a low colour temperature, i.e. a warm light colour, has a higher Ra value compared with an LED with a high colour temperature. The luminous efficacy from LEDs is constantly being improved and rapid development is being made.

The luminous efficacy from white LEDs will soon reach 100 lm/W i.e. a luminous efficacy corresponding to standard fluorescent lamps. LEDs with a high colour temperature, i.e. cold light colour, offer greater efficiency than equivalent LEDs with a low colour temperature. The reason for this is white diodes are basically a blue diode with a very high colour temperature.

The light distribution from an LED can be controlled/managed via the use of reflectors, lenses or some form of diffusing material. Lenses are usually directly linked to each manufacturer and the type of LED.

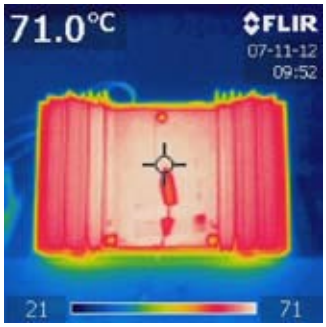
Life and durability

An LED when used correctly has a long life. An LED very rarely fails; instead the aluminous flux depreciates until it completely disappears. On LED data sheets the life span is stated for when there is 70 % of the luminous flux remaining (L70). This life span is approx. 35,000–50,000 hours for operations within the limit values given by the manufacturer. A decisive parameter for both life span and luminous efficacy is that an LED is run at a reasonable temperature.

LEDs neither emit ultraviolet (UV) nor infra-red (IR) radiation. This makes the light source ideal for use in environments where UV or irradiation is undesirable, for example, in museums or where food is being handled. Another advantage of LEDs is that they are not made up of moving or fragile parts. Manufactured correctly, LED solutions are robust and are resistant to vibration and other mechanical stresses. LEDs do not contain any environmentally hazardous substances, which simplifies recycling.

For more information go to www.barbourproductsearch.info

Heat development



The picture has been taken using a heat camera and illustrates thermal development from an LED assembly.

In spite of an LED being physically very small, great demands are made on correct cooling, either through the use of heat-sinks or through other smart design solutions. We apply the same high temperature margin demands during the development of LED products as for other products containing electronics in one form or another.

Ballasts

LEDs require specially designed ballasts, usually known as drivers, that convert 230 V mains voltage to appropriate parameters to run the LED. One type of LED operation is known as constant current, where the LED is powered with a constant current, usually 350 or 700 mA, but there are LEDs that can be run on higher currents. The voltage must be kept lower than 48 V DC. This type of operation permits LEDs to be connected in series, however, the total output per circuit must be adapted to the size and specification of the driver.

Systems consisting of strips, or self-adhesive tapes, accommodating a large number of LEDs are usually powered by a constant voltage of 8, 10, 12 or 24 V. Several strips can be connected in parallel to a common driver. It is important to rememberthat the voltage drop in cables is calculated in the same way as for traditional extra-low voltage lighting installations.

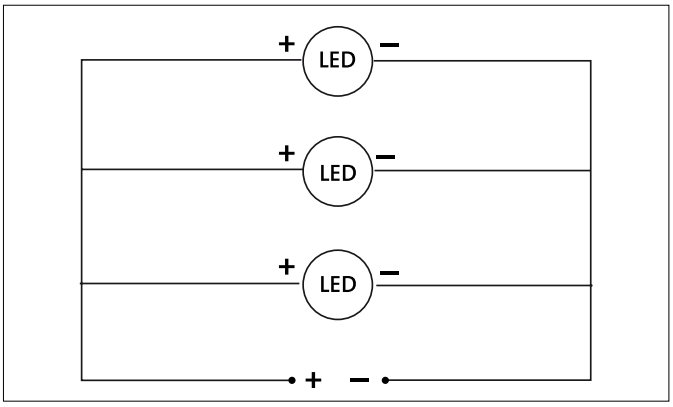
Irrespective of the type of operation it is important that the driver is matched correctly to the type of LED. The polarity is also important as it is direct voltage (DC) that powers the LED. Incorrect driver selection will damage or destroy the connected LED. A driver also needs to ensure electrical separation/isolation from the mains voltage, LED modules without protective isolation can therefore be touched without risk of electric shock.

Dimming

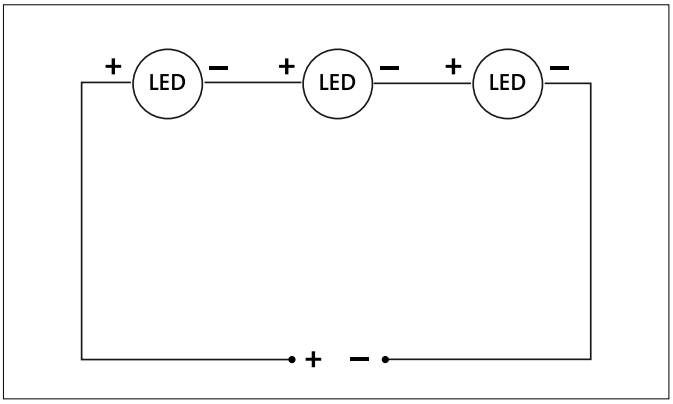
LED dimming is carried out through the use of drivers with pulse width modulation (usually abbreviated PWM). The LED is then powered using a technique consisting of square waves with varying frequency. The connected LED is switched on and off at a high frequency, which reduces the light level. Ballasts with PWM are available with different types of control interface including DALI, DSI, DMX512 and switchDIM.

Cable routing

It is important that the polarity is followed. Incorrectly connected LEDs can be destroyed or damaged. Usually a maximum cable length is stated for PWM units. Longer cables can create problems with control or generate EMC issues and downtime. The voltage drop must be taken into consideration in constant voltage circuits.



The LED is connected in parallel to the driver in constant voltage operation.



Constant current operation is chosen when the LED is connected in series to the driver.

For more information go to www.barbourproductsearch.info

Why HF-ballasts?

Research studies have indicated that people in workplaces where luminaires equipped with HF-ballasts are used feel better, are less tired and achieve more. Not everyone is aware of the flicker from fluorescent lamp luminaires equipped with ordinary ballasts, however the brain still registers the flashing.

As the HF-ballast utilises energy more efficiently, i.e. the installed luminaire output and performance losses are lower, there is also less heat. Thanks to this, cooling and air conditioning equipment can be dimensioned with a reduced output, giving both purchasing and operation cost savings.

Maintenance and service costs are lower due to the increased life of the light sources. When re-lamping you no longer need to change the starter, as the ignition function is integrated in the HF-ballast.

HF-ballasts are the environmental choice

HF-ballasts are environmentally friendly. The HF-ballast makes the greatest contribution towards the environment through energy savings. Another important environmental factor is that the life span of the fluorescent lamp increases on average by 15 %, which reduces the mercury load on the surroundings.

Function

An HF-ballast increases the fluorescent lamp's working frequency to approximately 40 kHz, and in doing so lights the fluorescent lamp completely evenly without flashing. At the same time efficiency is improved by approximately 10 %.

Ignition

An HF-ballast ignites fluorescent lamps in a controlled manner. The warm start means that uneven emissions from the cathodes are avoided, which is considered to extend the life span by up to 50 % where the switching on and off rate is deemed as normal. Using a warm start HF ballast, the cathodes are preheated before the fluorescent lamp receives its ignition pulse. In addition, modern high quality HF-ballasts have a function that significantly reduces or completely cuts this preheating current once the fluorescent lamp has ignited. An important function when taking energy savings into consideration, but also it means the T5 light source is powered under optimal temperature conditions.

Operation

When discharging starts and the fluorescent lamp ignites, the HF-ballast regulates all unnecessary parameters for an even luminous flux independent of fluctuations in the supply voltage. Furthermore, the HF-ballast monitors the function of the light source and switches it off if defects occur. There are HF-ballasts on the market that can indicate, via the light source, that a mains voltage fault has occurred, for example, over voltage.

Cable routing

A great deal of thought must be given to cable routing when designing luminaires for HF-ballasts.

Internal wiring to the fluorescent lamp must be routed in a way that does not impair functionality. Too long internal wiring to the fluorescent lamp can also cause interference issues (EMC).

Furthermore, the incoming mains cable must be taken into consideration. The mains cable, due to EMC requirements, must not be routed together with internal wiring. For this reason luminaires usually feature a separate channel or row of clips to correctly route these cables.

Master–slave

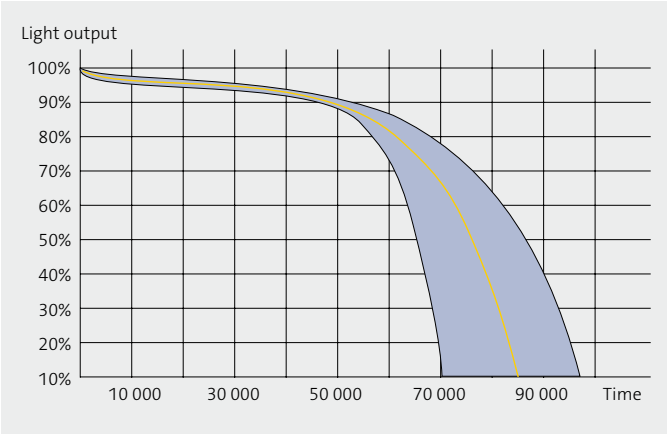
Master-slave solutions, where two interconnected luminaires are fed by a single HF-ballast placed in one of the units, can only be recommended for HF-standard and where internal wiring can be kept shorter than 1 m. Master-slave solutions for HF-dimming are not recommended due to the very high risk of defective functionality (different light levels from the luminaires).

In the master-slave solutions for Dimming, only the control signal from the HF-ballast of the master luminaire should be considered; this then controls the HF-ballast in the slave luminaire, which is not the same procedure as the one described above.

Advantages of HF-ballasts:

- Quick, flicker free ignition.
- Flicker free lighting.
- Very small magnetic field.
- The light source works under optimal conditions and gives the correct luminous flux independent of fluctuations in the supply voltage.
- Extends the life span of the light source.
- Low harmonics (THD).
- Switches off defective fluorescent lamps (no disturbing flashing).
- Save 20 % energy on average. A 60 % saving is possible through dimming, constant light control and/or with occupancy detection.
- Dimming of fluorescent lamps is only possible with HF-ballasts.
- Low thermal loss.
- No stroboscopic effect.

For more information go to www.barbourproductsearch.info



The life span spread of an HF-ballast. After 50,000 hours, at least 90 % of all HF-ballasts work if the temperature of the control gear's tc-point (reference point) does not exceed the manufacturer's defined value for that life span.

Life span HF-ballasts

The life span of the HF-ballast is, like other electronic equipment, limited. It is determined by, among others, component selection, mains fluctuations, ignition rate and first and foremost the ambient temperature inside the luminaire. The electronic components' fault frequency causes failures on a few HF-ballast during the first hours of operation. HF-ballast faults then occur evenly over a period of time, like fluorescent lamps.

The life span and function can be jeopardised by incorrect handling during installation. The HF-ballast can be destroyed by:

- Incorrect measuring of the insulation resistance.
- Current peaks caused by machinery at the workplace.
- Over temperature, if the luminaire is used in a space with increased temperature (normal temp. > 25 °C). The luminaires' ta (max permitted ambient temperature) is in most cases 25 °C, but luminaires with heightened ta are available.

The life span of the HF-ballast, as previously described, is dependent in part on the ambient temperature. Normally there is a temperature control point (tc-point) on the HF-ballast, which should be checked when the ballast is positioned in the product in question. The tc-max varies between manufacturer and type and defines the highest permitted temperature to prevent damage to the ballast. HF-ballasts with a high tc-max are not necessarily better than models with a low tc-max. The HF-ballast manufacturer may have chosen to place the reference point at a cool or warm position on the HF-ballast.

The life span of an HF-ballast is stated at a specific temperature on the tc-point. Sometimes this corresponds with tc-max, but it can also be stated at a lower temperature. Manufacturers usually state 50,000 hours as the life span with a maximum depreciation of 0.2 %/1000 hours, which corresponds to a 10 % dropout.

The cooler the tc-temperature, the longer the life span. A rule of thumb is that a 10° reduction in temperature on the tc-point doubles the life span while a 10° increase in temperature halves this.

HF-ballasts for demanding environments, HF Industry

HF Industry is a ballast designed for use in rugged and demanding environments. Examples are industrial environments where:

- mains voltage transients are a problem
- the atmosphere is dustier than normal
- the atmosphere is slightly more humid than normal
- heavy vibrations occur

The HF-ballasts are designed for a life span of 100,000 hours (10 % depreciation) under the condition that the temperature is kept below specific levels (according to the spec. for the HF-ballast). They are also designed with IVG (Intelligent Voltage Guard) which both warns and protects against overvoltage and undervoltage. The HF-ballasts are also designed to withstand mains voltage transients up to 4 kV. The more robust HF-ballast offers longer maintenance intervals, which reduces maintenance costs to a minimum.

Ballasts are not available in HF-dim or in slimline designs, which means they cannot be used in all luminaires. The ballasts are primarily intended for products in industrial environments, products that are usually equipped with high lamp outputs and where there is physical space for the HF-ballasts. The use of these HF-ballasts in other types of luminaires, for example office luminaires, does not normally give any advantages compared to using HF-std.

For product ranges, please refer to the industrial luminaires chapter.

Terminology

Warm start
Correctly optimised ignition of fluorescent lamps, where the cathodes at the ends of the lamp are preheated to the right temperature, allowing controlled discharging to take place. This creates the best conditions for maximising the fluorescent lamps life span.

Cold start
Igniting fluorescent lamps without preheating the cathodes, causes the cathodes' emissions-material to be consumed quicker. The advantage this offers is smaller and less expensive electronic control gear. These are suited only for industrial premises, and places, where fluorescent lamps are not switched on and off more than once or twice a day.

Nominal voltage
The operating voltage is stated on the luminaire label. Normally, HF-ballasts work without problems within ±10 % fluctuation of the nominal voltage. Check the voltage is correct. Too high or too low can damage the electronics. Most HF-ballasts also work with direct voltage. Please contact us for this type of operation.

Harmonics
Harmonics are distortions of the mains voltage's waveform caused by non-linear loads on the mains. Harmonics give rise to distorted currents, high magnetic fields and interference to sensitive electronic apparatus. Computers, frequency converters, standard compensated luminaires are large harmonic producers. The guideline value for computers is approximately 80 % THD, standard luminaires approximately 20 % THD and HF-ballasts about 10 %. Low quality HF-ballasts can be large producers of harmonics.

THD
Total Harmonic Distortion.

Operating frequency
is the discharge current's frequency in the fluorescent lamp. In luminaires with magnetic ballasts this equals the mains frequency 50 Hz. HF-ballasts convert the mains frequency to approximately 25–50 kHz. The luminaire's efficiency is also improved by approximate 10 % in this case. As the operating frequency also modulates light, this can cause problems with infrared detectors used in alarm systems and lighting control. The problem can however be avoided through the right choice of HF-ballast.

Cathode
Also called electrode. The cathodes at each end of the fluorescent lamp are made of tungsten filaments, coated with beryllium oxide. When heated, electrons are released which maintain the lamp's discharging current. Incorrect temperature on the cathodes shortens the lamp's life span. This occurs primarily with dimming when the fluorescent lamp output drops, which can seriously shorten the lamp's life span. This is avoided by using high quality HF-ballasts.

For more information go to www.barbourproductsearch.info

Fagerhults policy

When designing luminaires we make sure that the temperature of the HF ballast does not become too high, as this can shorten the life span. When a luminaire is installed and used correctly the life span for the HF-ballast is at least 50,000 hours with a maximum 10 % fault frequency. This applies at an ambient temperature of 25 °C (ta) unless otherwise stated for the product.

We also employ our own policy where we set more stringent requirements, over and above the tc-temperatures stated by the HF-ballast manufacturers. We have voluntarily chosen to add a general safety margin of 5° during testing. This margin may be seen to be small, however, it results in an expected longer theoretical life span for our products compared with using the data provided by the HF manufacturers.

The choice of the right HF-ballasts for respective products is also important. Unfortunately at the present time there is no HF-ballast on the market which, in all technical respects, is best. Some ballasts have better EMC-properties than others, some are cooler and some have lower leakage current. There is also a great deal of difference in size between different HF ballasts. We consider these parameters and then select the ballast that is best suited to the luminaire in question.

Fagerhult only uses high quality HF-ballasts from leading manufacturers in its luminaires.

Temperature example

Examples of temperature margins for a number of typical luminaires are presented below. The stated margins concern luminaires with standard HF. The margin relates to the maximum tc-temperature stated by the manufacturer to give a life span of at least 50,000 hours with a maximum failure rate of 10 %. Please contact our customer service department if you require data for other products.

Product	Output	Temperature margin
Luminaires for fluorescent lamps		
Loop Light	3x35 W	> 20 °C
Zora	2x54 W	> 25 °C
Ten° Line	3x28 W	> 15 °C
Closs	2x35 W	> 15 °C
Excis	4x54 W	> 5 °C
Recessed fluorescent lamp luminaires		
MultiFive	2x49 W	> 10 °C
Indigo Clivus	2x54 W	> 5 °C
Indigo Combo	2x28 W	> 20 °C
Pozzo	1x60 W	> 15 °C
Industry luminaires		
Inducon (ta35)	2x49 W	> 15 °C
Densus	2x49 W	> 5 °C
Scatola	2x54 W	> 15 °C
AllFive	2x35 W	> 15 °C
Downlights		
Pleiad Comfort G2	1x32 W	> 10 °C
Pleiad Compact surface	1x26 W	> 20 °C
Pleiad Compact G2	2x26 W	> 15 °C
Decorative luminaires		
Discovery	1x26 W	> 10 °C
Discovery Space	2x18 W	> 15 °C

For more information go to www.barbourproductsearch.info

Miniature Circuit Breakers

Miniature circuit breakers for groups of luminaires equipped with an HF-ballast should be sized not only according to the rated current but primarily with regard to the inrush current. The initial inrush current that occurs when the luminaires are switched on can cause the miniature circuit breaker to trip if this is sized incorrectly.

The inrush current is caused by the capacitors in the HF-ballast's mains filter. The size of the inrush current is not dependent on the output of the HF-ballast's but its design. The inrush current varies from one HF-ballast manufacturer to another. Due to the characteristics of the inrush current we recommended that miniature circuit breakers with tripping characteristic C are used.

If there is a need to connect more HF-ballasts than that stated in column 1 please contact our customer service for exact data.

As manufacturers continuously develop their products the data on this page is not binding. For the latest data, please check with the manufacturers of individual HF-ballast.

We reserve the right to make alterations and make reservations for possible printer's errors.

The number of HF-ballasts that can be connected to a circuit, protected with a 16 A miniature circuit breaker of type C, is shown in the table below. We list two different values:
Column 1 – the value indicates the maximum number of HF-ballasts that, independent of brand and type (Osram, Philips, Tridonic, Helvar) which we use, can be connected to the miniature circuit breaker.
Column 2 – the value indicates the maximum number of HF-ballasts that can be fuse protected for certain brands.

The value should be seen as an indication of what is possible. Most brands and types of HF-ballast lie between the values stated in column 1 and in column 2.

T5

Output	HF-std		HF-dim	
	Column 1 All HF-ballasts	Column 2 Some HF-ballasts	Column 1 All HF-ballasts	Column 2 Some HF-ballasts
1x14	47	122	47	150
2x14	28	47	20	78
3x14	44	47	38	38
4x14	42	47	26	42
1x21	47	86	47	120
2x21	28	47	20	60
1x24	44	103	47	150
2x24	20	53	38	52
1x28	47	86	26	83
2x28	28	47	20	48
1x35	47	86	38	76
2x35	28	47	18	33
1x39	44	61	47	76
2x39	20	32	20	31
1x49	44	56	38	48
2x49	20	26	18	26
1x54	38	47	25	76
2x54	20	26	20	30
1x80	20	30	20	38
2x80	16	20	15	20

T5 Eco

Output	HF-std		HF-dim	
	Column 1 All HF-ballasts	Column 2 Some HF-ballasts	Column 1 All HF-ballasts	Column 2 Some HF-ballasts
1x13	47	122	47	150
2x13	28	47	20	78
3x13	44	47	38	38
4x13	42	47	26	42
1x20	44	103	47	150
2x20	20	53	38	52
1x25	47	86	26	83
2x25	28	47	20	48
1x32	47	86	38	76
2x32	28	47	18	33
1x45	44	56	38	48
2x45	20	26	18	26
1x50	38	47	25	76
2x50	20	26	20	30
1x73	20	30	20	38
2x73	16	20	15	20

For more information go to www.barbourproductsearch.info

T5C

Output	HF-std		HF-dim	
	Column 1 All HF-ballasts	Column 2 Some HF-ballasts	Column 1 All HF-ballasts	Column 2 Some HF-ballasts
1x22	33	74	24	54
1x22+1x40	22	56	-	-
1x40	33	74	24	54
1x55	47	50	20	34
1x60	47	47	20	20

T8

Output	HF-std		HF-dim	
	Column 1 All HF-ballasts	Column 2 Some HF-ballasts	Column 1 All HF-ballasts	Column 2 Some HF-ballasts
1x18	48	122	47	86
2x18	48	75	20	70
3x18	20	80	24	56
4x18	20	56	20	38
1x36	47	82	47	70
2x36	37	56	20	56
1x58	47	60	40	56
2x58	20	26	20	30
1x70	34	47	-	-
2x70	18	20	-	-

FSD

Output	HF-std		HF-dim	
	Column 1 All HF-ballasts	Column 2 Some HF-ballasts	Column 1 All HF-ballasts	Column 2 Some HF-ballasts
1x18	48	74	40	56
2x18	38	56	16	38
1x24	47	103	27	86
2x24	20	56	12	52
1x36	47	56	47	70
2x36	44	56	20	34
1x40	47	74	47	70
2x40	20	38	20	30
1x55	26	50	40	56
2x55	18	20	18	26
1x80	30	30	20	48
2x80	16	16	15	18

FSQ

Output	HF-std		HF-dim	
	Column 1 All HF-ballasts	Column 2 Some HF-ballasts	Column 1 All HF-ballasts	Column 2 Some HF-ballasts
1x13	34	82	40	40
2x13	34	56	60	60
1x18	35	82	38	70
2x18	35	80	26	47
1x26	33	74	38	70
2x26	20	56	20	46

FSM

Output	HF-std		HF-dim	
	Column 1 All HF-ballasts	Column 2 Some HF-ballasts	Column 1 All HF-ballasts	Column 2 Some HF-ballasts
1x13	34	118	40	40
2x13	34	116	60	60
1x14	47	94	47	47
2x14	47	94	47	47
1x17	47	94	47	47
2x17	47	94	47	47
1x18	35	152	38	70
2x18	35	128	26	48
1x26	33	144	38	70
2x26	20	102	20	46
1x32	33	124	38	50
2x32	20	82	20	26
1x42	33	124	38	50
2x42	20	82	12	26
1x57	36	94	22	38
2x57	17	17	-	-

- = no current data available

Additional comments

- With fuse protection of luminaires, consideration should also be taken of the inrush current as well as the combined rated current for the groups' luminaires, the cable's cross-section and the average length of the group's cabling.
- The figures listed in the above tables assume a simultaneous ignition (same switch) at the mains voltage peak value.
- The values in the tables apply for 1-pole miniature circuit breakers. When using multi-pole miniature circuit breakers the number of luminaires should be reduced by 20 %.
- When using 16 A miniature circuit breakers with B characteristics the size of the groups should be reduced by half. For 10 A miniature circuit breakers with C characteristic the size of the group should be reduced by approximately 40 %. For exact sizing please contact our customer service team.

For more information go to www.barbourproductsearch.info

Information about circuit load

The system circuit load is the sum of the light source's power consumption and losses in the associated control gear. An installation must be designed to take into account the starting current as well as the total power consumption. Normally it is the starting current, and not the system output, that dictates how many HF-ballasts can be connected to a miniature circuit-breaker (MCB). Information regarding the maximum number of HF-ballasts per miniature circuit-breaker can be found on Fuse Protection page within the technical section.

The system and lamp wattages for a number of different HF-ballasts are presented below. As standard Fagerhult's luminaires are equipped with warm start HF-ballasts, where pre-heating of the cathode is either reduced or ceases completely when the light source is ignited. This function saves energy.

Note: Figures may vary for other HF-ballasts. The stated values are examples and are rounded to the closest integer. Development of HF-ballasts is ongoing and defined values may be subject to change.

The power factor, cosfi, lies between 0.95 and 0.99 for luminaires equipped with HF-ballasts.

- SW = System W
- - = at present there is no control gear or data available

T5 Eco					
HF-standard	**1x**	**2x**	**3x**	**4x**	
Light source	**SW**	**SW**	**SW**	**SW**	**Applies to**
13	17	31	44	58	Philips HF-P EII
25	29	55	-	-	Philips HF-P EII
32	36	70	-	-	Philips HF-P EII
20	24	48	68	89	Philips HF-P EII
45	51	100	-	-	Philips HF-P EII
50	55	108	-	-	Philips HF-P EII
73	81	158	-	-	Philips HF-P EII
HF-dim	**1x**	**2x**	**3x**	**4x**	
Light source	**SW**	**SW**	**SW**	**SW**	**Applies to**
13	17	32	47	62	Philips HF-R EII
25	30	57	-	-	Philips HF-R EII
32	37	71	-	-	Philips HF-R EII
20	24	48	71	96	Philips HF-R EII
45	51	96	-	-	Philips HF-R EII
50	56	109	-	-	Philips HF-R EII
73	80	159	-	-	Philips HF-R EII

T8					
HF-standard	**1x**	**2x**	**3x**	**4x**	
Light source	**SW**	**SW**	**SW**	**SW**	**Applies to**
18	19	37	54	70	Philips HF-P EII
36	37	70	-	-	Philips HF-P EII
58	56	107	-	-	Philips HF-P EII
HF-dim	**1x**	**2x**	**3x**	**4x**	
Light source	**SW**	**SW**	**SW**	**SW**	**Applies to**
18	21	39	65	79	Philips HF-R
36	38	74	-	-	Philips HF-R
58	56	113	-	-	Philips HF-R

T5					
HF-standard	**1x**	**2x**	**3x**	**4x**	
Light source	**SW**	**SW**	**SW**	**SW**	**Applies to**
14	18	33	47	62	Philips HF-P EII
21	25	47	-	-	Philips HF-P EII
28	32	61	-	-	Philips HF-P EII
35	39	76	-	-	Philips HF-P EII
24	28	56	80	105	Philips HF-P EII
39	44	86	-	-	Philips HF-P EII
49	55	108	-	-	Philips HF-P EII
54	60	118	-	-	Philips HF-P EII
80	88	172	-	-	Philips HF-P EII
HF-dim	**1x**	**2x**	**3x**	**4x**	
Light source	**SW**	**SW**	**SW**	**SW**	**Applies to**
14	18	34	50	66	Philips HF-R EII
21	25	48	-	-	Philips HF-R EII
28	33	63	-	-	Philips HF-R EII
35	40	77	-	-	Philips HF-R EII
24	28	56	83	112	Philips HF-R EII
39	43	84	-	-	Philips HF-R EII
49	55	106	-	-	Philips HF-R EII
54	61	119	-	-	Philips HF-R EII
80	87	173	-	-	Philips HF-R EII

T5C		
HF-standard	**1x**	
Light source	**SW**	**Applies to**
22	25	Philips HF-P EII
40	43	Philips HF-P EII
22+40	66	Philips HF-P EII
55	60	Philips HF-P EII
60	65	Philips HF-P EII

For more information go to www.barbourproductsearch.info

FSM-E			
HF-standard	**1x**	**2x**	
Light source	**SW**	**SW**	**Applies to**
14	16	32	Philips HF-P EII
17	19	38	Philips HF-P EII
18	21	40	Tridonic PC-PRO
26	29	56	Tridonic PC-PRO
32	35	71	Tridonic PC-PRO
42	46	94	Tridonic PC-PRO
57	64	121	PC-PRO/Ph. HF-P PL-T

HF-dim	**1x**	**2x**	
Light source	**SW**	**SW**	**Applies to**
14	17	33	Philips HF-R EII
17	20	39	Philips HF-R EII
18	21	40	Tridonic PCA Excel
26	28	55	Tridonic PCA Excel
32	36	71	Tridonic PCA Excel
42	47	91	Tridonic PCA Excel
57	66	-	Tridonic PCA Excel

FSQ-E			
HF-standard	**1x**	**2x**	
Light source	**SW**	**SW**	**Applies to**
13	14	28	Philips HF-PL-T/C
18	20	39	Philips HF-PL-T/C
26	28	54	Philips HF-PL-T/C

HF-dim	**1x**	**2x**	
Light source	**SW**	**SW**	**Applies to**
13	16	31	Tridonic PCA ECO
18	21	40	Tridonic PCA ECO
26	28	58	Tridonic PCA ECO

FSD-H			
HF-standard	**1x**	**2x**	
Light source	**SW**	**SW**	**Applies to**
18	20	40	Osram QT
24	26	50	Osram QT
36	38	75	Osram QT
40	44	90	Osram QT
55	61	116	Osram QT
80	86	176	Osram QTP, QT-FQ

HF-dim	**1x**	**2x**	
Light source	**SW**	**SW**	**Applies to**
18	18	37	Osram QTi DIM
24	26	50	Osram QTi DIM
36	36	70	Osram QTi DIM
40	42	82	Osram QTi DIM
55	59	115	Osram QTi DIM
80	88	165	Osram QTi DIM

MTm/MT/MD/MR		
Electronic ballast	**1x**	
Light source	**SW**	**Applies to**
20 (MTm)	25	Philips HID-PV m
35	45	Tridonic PCI
70	80	Tridonic PCI
150	160	Tridonic PCI

For more information go to www.barbourproductsearch.info

Most luminaires are designed to give the best performance at normal room temperature. In a cold area, for example, certain store spaces or freezer rooms, the ambient environment for the luminaire is very different. Many industrial luminaires are suitable for use in this situation, but there are a number of parameters to bear in mind in order to choose the right luminaires.

The selection of the luminaire and its placement in the room are governed by:

- What is the room temperature?
- What IP-class is required?
- Where are the chilled beams or conditioning units placed? Is the luminaire exposed to air currents?
- Is there a risk of the luminaire being subjected to mechanical effects?
- Should the luminaires be on continuously or are they switched on/off at specific intervals/days?

General

Open reflector luminaires are designed so that the maximum luminous flux is obtained at a normal room temperature of 25 °C. When this kind of luminaire is placed in a cold space the luminous flux and the ignition ability are affected. The lower luminous flux must be taken into consideration during light planning.

On the other hand, luminaires with a degree of protection equal to IP 44 and upwards can operate, from a luminous flux standpoint, better when placed in a colder environment as the light source's ambient temperature is usually a little too high when the luminaire is at normal room temperature. In this situation, the luminous flux increases, up to a certain point, as the ambient temperature drops.

Ballasts

It is important to use the right ballast to ensure the luminaire also ignites at low temperatures. The temperature specifications vary for different manufacturers and ballast.

Light sources

The T5 light source emits its maximum luminous flux at an ambient temperature (around the lamp) of 35 °C. The temperature around the light source is controlled by the design of the luminaire. For luminaires with a degree of protection equal to IP 44 and upwards the light source can heat the space around itself even when the ambient temperature around the actual luminaire is low. This is why T5 luminaires can work very well even in cold surroundings.

The T8 light source is slightly different compared to the T5. It has its maximum luminous flux at a lower temperature, 25 °C. Consequently, the T8 light source emits a higher luminous flux than T5 at certain, lower, ambient temperatures.

Thermo-lamps

In some locations the use of thermo-lamps maybe required. Thermo-lamps have an extra outer glass that insulates (thermal principle). The disadvantage of these lamps is that they have a larger diameter, which can cause problems in some luminaires. Thermo-lamps are available in both T5 and T8 designs, though not in all outputs. Please refer to the light sources chapter for more information.

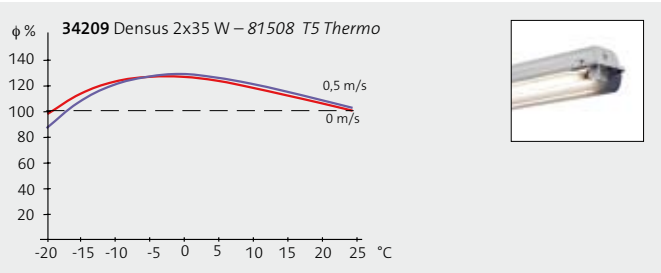
Placement

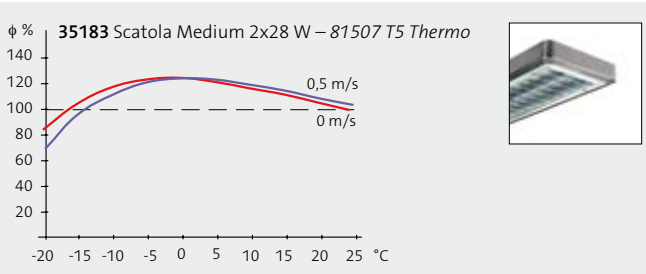
Luminaires should not, if possible, be placed too close to chilled beams or air conditioning units. The cold air currents can have a very negative effect on the luminous flux. This also applies to enclosed luminaires or when using thermo-lamps.

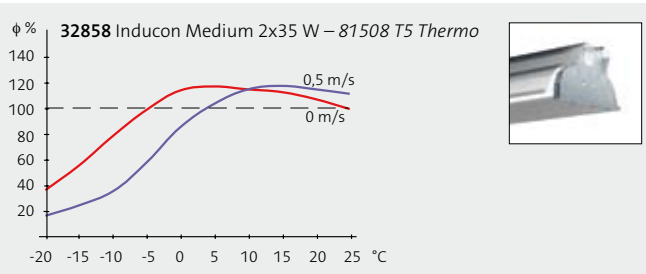
Actual luminous flux

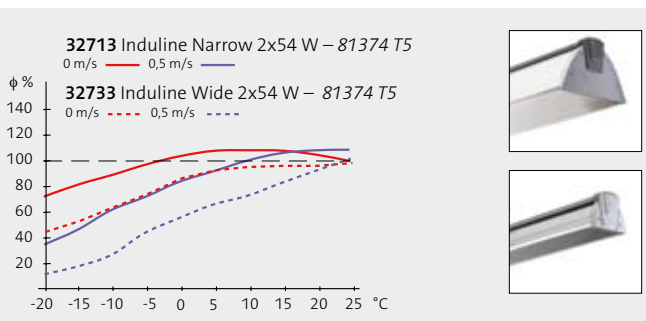
The graphs below show how the luminous flux is affected by ambient temperature for a number of typical industrial luminaires. The red curve indicates the luminous flux with no air movement and the blue indicates the flux with an air flow of 0.5 m/s. As a reference value the luminous flux at +25 °C with no air movement is used.

Text and order numbers in italics denote the light source.
The stated values are intended as a guide only and not an absolute value. Please factor in a good margin when designing.









For more information go to www.barbourproductsearch.info

CE-marking

In order for a luminaire to be marketed in the EU/EES region it must be equipped with a CE-mark.

The CE-marking, which is compulsory, means that the manufacturer certifies to the authorities that the product conforms to relevant safety requirements within the EU. Impartial testing for most products is not required.

Third party certification – for your safety

Fagerhult has chosen, despite third party certification no longer being required, to continue with this procedure for its basic range. This is to ensure that the customer receives products that conform to all current safety requirements with the added reassurance of being inspected by an independent body.

Variants of the basic range, for example, products with HF-dim or with emergency light functionality, are not usually certified by a third party. However, the safety levels on these designs are just as high as for other products.

We collaborate with Intertek ETL Semko for third party certification. This is a company that has vast experience within testing as with a good reputation across Europe.

The collaboration means our products can be given an S- or ENEC-mark. S- or ENEC-marking indicates objective testing and inspection of the electrical component´s safety for:

- Fire
- Electric shock
- Mechanical damage
- Radiation and burn injuries
- Environment impact with respect to:
  - Intended or expected usage
  - Intended or expected usage period
  - Expected fault conditions
  - Expected, reasonable incorrect use

ENEC-marking

The S-mark has been well known for many years. In recent times it has also been possible to ENEC-mark luminaires. ENEC stands for European Norms Electrical Certification.

The ENEC system currently encompasses some 21 different countries. The ENEC mark has the same value as each member country's own approval symbol. A separate agreement with the supervising national body is required in order to ENEC-mark luminaires, in our case Intertek ETL Semko, and to certify that the quality system in production corresponds to the requirements set out in ISO 9002.

SMTA-agreement – laboratory accreditation

Our laboratory, Technical Centre, has had an SMTA-agreement with Intertek ETL Semko since 1993. An SMTA-agreement, Supervised Manufacturers Testing Authorisation, means that we have permission to carry out all requisite testing for S- as well as ENEC-marking. The results from these tests form the basis for certification. The agreement means that Intertek ETL Semko has inspected and approved our test equipment and quality system as well as the expertise of our personnel. In addition to annual audits, Intertek ETL Semko also has the right to visit our laboratory at any time or call in products for comparison tests.

The Technical Centre is also very well equipped with instruments to perform other tests on luminaires. Instruments of the highest quality and accuracy are in place to inspect the product's EMC-properties (in accordance with EN 55015), to verify lighting performance and other quality tests.

Standardisation

We also participate in standardisation work within the field of luminaires via our membership of the Swedish Electrical Commission team TK34 and TK89. At the international level we are represented in the team WG1 LUMEX within the IEC (International Electrotechnical Commission). This team discusses proposals for amendments to testing standards. Consequently, we have the possibility to influence new standards as well as keeping ourselves well informed about future amendments. Being aware of forthcoming requirements and seeing trends within standards are very important in the product development process.

Read more about Semko and third party certification at www.intertek-etlsemko.com.

Our laboratory, Technical Centre, has had an SMTA-agreement with Intertek ETL Semko since 1993.

A product's EMC-properties (according to EN 55015), lighting performance and other quality properties are tested at the Technical Centre.

For more information go to www.barbourproductsearch.info

Die casting

Die casting of metal is a method of production that produces strong parts, a high quality finish and a lot of integrated functionality. With zinc the parts are ready for use immediately after leaving the moulding room. For aluminium the remains from the stub will, generally, need to be shaped. The parts are normally rolled to remove burrs and soften the edges.

Die casting of aluminium

Aluminium is moulded at high pressure, which requires the tooling to have exact tolerances and good sealing surfaces to contain the material being moulded which has a consistency like water. There are advantages to die cast aluminium parts, such as a high strength to weight ratio. The most common aluminium alloy used by Fagerhult is AlSi8Cu3.

Another advantage of aluminium is that it can be readily recycled. Recycling uses a fraction of the energy required to manufacture virgin material.

Die cast aluminium is used in parts such as outer and inner caps, continuous couplers and various types of bracket.

Die casting of zinc

Zinc is a corrosion-resistant material with good mechanical properties. The main difference between zinc and aluminium is the weight: zinc is 2.5 times heavier, but has inferior heat resistant properties and a lower creep strength. The advantages of zinc are that it is easier to mould, melts at a lower temperate and is therefore gentler on the tool. A properly made zinc tool can handle close to 1 million cycles with good quality results and high repetition precision.

With zinc it possible to produce thin products with a high finish on the surfaces, important for the treatment of visible surfaces such as chrome or nickel-plating. The parts are usually ready for use immediately following die casting with no further shaping required except, occasionally, for rolling.

The areas of application are the same as for aluminium, but zinc is better suited for applications which require a significantly higher measurement tolerance or finer requirements for the surfaces.

Extrusion

Extrusion is a process that can be done with both aluminium and plastic. The method is cost-effective and provides options for integrating functions and fine detail. It is possible to combine extruded plastic and aluminium parts.

Extrusion of aluminium

The material, which at the start is called bloom, is heated and moulded at great force through a profile tool. Depending on the size of the profile and capacity of the machine, it may be necessary or desirable to manufacture several profiles at the same time. However a single profile is more usual.

Following moulding the profile is stretched, causing it to straighten. The material is then tempered in a furnace; in this state, the profiles are normally a good 6 metres in length. Cross-cutting, shaping and anodising are additional processes that can be performed if required.

Anodising involves adding a protective oxide layer to the surface using an electrolytic process that provides a hard, sealed surface. Natural anodising is most common and various different colours can be introduced.

Extrusion of plastic

The materials PC and PMMA are the most frequently used plastics in the lighting industry and are mainly used in a transparent form for shades and covers. The process allows the cost-effective production of parts in long designs and with a high degree of precision. It is also possible to combine materials to produce clear and opal surfaces, or to combine the strength of polycarbonate with the good UV resistance of acrylic.

The parts expand as they become warmer, so this must be taken into consideration when developing new products. Cross-cutting tolerances on shades should allow for tolerances of other parts they are to be used with. This, as standard, can result in gaps being visible at the ends of luminaires.

For more information go to www.barbourproductsearch.info

Sheet metal

Sheet metal, in various qualities, hardness's, thickness's and surface treatments, is widely used in light fittings. The material provides a good balance between function and cost. Sheet metal has the advantage that it can be formed quickly in constant production, allowing the final product to be completed at a later stage, facilitating flexible production. From the raw material (sheet metal), it is possible to run through the processes of punching, bending, welding and painting to final fitting instantly, with the only restrictions being the capacity of the manufacturer.

Certain parts may require the use of so-called deep drawing quality (soft sheet) metal, i.e. sheet metal stretched so intensely that ordinary sheet metal qualities would break.

Black sheet

Black sheet, also referred to as iron plate, is an untreated sheet metal that is extremely prone to rusting, at different rates depending on the composition of the external environment. To avoid corrosion, the sheet plate is surface treated (powder coated, for example), usually using an epoxy-polyester mixture. The coating process is free of aromatic solvents and heavy metals.

This quality is most frequently used for light fittings designed for use in a dry environment such as offices, corridors, classrooms, etc.

Aluminium-zinc coated sheet metal

Coating sheet metal with aluminium-zinc is a very effective way of preventing corrosion. Aluzink® coated sheets are made in the same way as hot-dip galvanised sheet metal, but use a mixture of approximately 55 % aluminium and 43 % zinc, rather than just zinc, to coat the surface. Parts made of Aluzink® are immediately ready for use following shaping, welding and bending. It is therefore cost-effective as, in some cases, the need for lacquering can be avoided. When welding and cutting, the cut surfaces self-seal to restore rust protection.

The moiré effect of Aluzink® gives it an aesthetically pleasing effect. The sheet is normally used in industrial luminaires as a casing or end piece. Other applications include brackets and other sheet metal parts that are not normally visible but which require protection against rust.

White rust can occur in some humid or otherwise extreme environments. Aluzink® is a registered trademark of SSAB.

Stainless steel

Stainless (rustless) steel is, as the name suggests, steel that cannot rust. This, however, is a fact that requires qualifying, as stainless steel can rust even though its resistance to corrosion is good. Perhaps, instead, it should be called rust-resistant steel. In order to retain the rust protection of steel, acid must be allowed to come into contact with the surface. This makes it important to keep the surface of the sheet properly cleaned.

The steel gains its properties through various alloys, including chrome, nickel and molybdenum. Depending on its composition, it is possible to have magnetic steel that can be hardened or non-magnetic steel that cannot be hardened. Its non-rusting qualities are very well suited for use in springs and Fagerhult also makes casings and brackets in stainless steel where suitable.

Acid-proof stainless steel

Acid-proof stainless steel has even greater resistance to corrosion than stainless steel. The steel gains its properties through various alloys, including chrome, nickel, manganese, titanium, niobium and molybdenum.

This is the highest level of protection offered by Fagerhult and is normally associated with luminaires designed for external environments, such as industrial activities which handle acids, salts and other corrosive substances. An installation that is close to the coast can also put a strain on normal lighting fittings. Acid-proof stainless steel can still corrode if the surface becomes coated in dirt and acid is not able to penetrate down to the surface of the material.

Usually, acid-proof stainless steel is combined with other equally hardy materials such as glass rather than plastic so as to ensure the best possible encapsulation.

Aluminium with good light-reflecting properties

For good light-reflecting properties, it is important to use extremely clean materials. Allowing the degree of cleanliness to fall by a tenth of a per cent can cause a significant loss in efficiency. There are compositions of sheet metal (platings) where the base material is "impure" and is covered with a layer of pure aluminium. The surface is then chemically anodised to make it resistant to oxidation by contact with acid or other substances. Plated materials offer one solution for combining good performance with low cost.

Other ways of producing effective reflective sheet surfaces (factor > 92 %) are to use a layer of oxide and to vacuum metallise the surface. See the section on louvres and reflectors.

Various impressions can be made in the sheet surface to provide a structure that disperses or collects the light in a deliberate way.

For more information go to www.barbourproductsearch.info

Plastic

Plastic is a modern material that is being constantly developed offering a range of benefits. The scope for designing with this material is improving, several functions can be used for integration and the designs can also be made lighter compared with metal designs. Production efficiency is good, since plastic parts rarely require additional shaping. Right from the start, the part has the correct surface structure and colour without the needing to be cleaned or trimmed.

From an environmental stance, plastic uses significantly less energy in the production of plastic parts compared to metal parts. The total amount of oil used in the manufacture of plastic parts is significantly smaller, too. Additionally plastic can be reused, either recycled as new products or used for energy.

A number of Fagerhult's markets place particular fire classification requirements on products inclusive of plastic. This may require the use of flame-retardant plastics in our parts to reduce the risk of fire starting or spreading via our luminaires. Fagerhult abides by the RoHS Directive, which prohibits the use of mercury, cadmium, lead, hexavalent chrome and the flame-retarding agents PBB and PBDE. A good choice of materials and good design solutions can avoid the need for flame-retardant agents (including the less harmful ones).

As stated above, there are many advantages to using plastic, but at the same time it places great demands on design and choice of materials. Depending on the area of application for the product and other specifications, tests and simulations must be constantly carried out during the development phase to ensure that all requirements are met without jeopardising safety and quality.

There is a whole host of different plastics available on the market. Each has been produced to meet the demands made of the products. A selection of plastics is given below.

PVC (polyvinyl chloride)

PVC is a polymer that consists of several vinyl chloride molecules bonded together. It is a thermoplastic produced by adding chlorine to ethylene and is often used in the construction industry, for pipes, plastic mats and insulation of cables/wires, for example. A material consisting solely of polyvinyl chloride is quite stiff, and for this reason softeners (phthalates) are generally added to make it easier to handle and more durable. The material has good chemical and weather resistance properties.

When PVC burns, hydrochloric acid and chlorinated hydrocarbons are formed because of the plastic's chlorine content. The smoke produced when burning is aggressive, attacking metals and electronic equipment in the building. The associated cleanup cost following such a fire causes many customers to prefer other alternatives instead.

The softeners are constantly given off and can migrate to and attack other plastic materials. They are also considered to be damaging to the environment and injurious to health and they can adversely affect reproduction.

Fagerhult products are connected internally using PVC-free wires and the mains cable can also be supplied to special order in a PVC-free design. Otherwise, PVC is not a material that is found in our products.

PC (polycarbonate)

Polycarbonate is both a transparent and a coloured thermoplastic with very high strength, including at low temperatures. It is often used in applications that require resistance to knocks, blows and kicks, including visors, machinery protection, CDs and other products that need to be durable and/or transparent. The material is self-extinguishing. When designing, it must be ensured that the material is not exposed to continuous tension as this will ultimately lead to cracks forming.

Polycarbonate can be cold bended (roughly like sheet metal), extruded lengthways or injection moulded. In lighting, it is used to insulate lamp holders and bodies as well as for shades, reflectors and dust protection. PC is often the material of choice for plastic luminaires sold as vandal proof.

Polycarbonate is sensitive to rippling and has limited resistance to UV light, which turns the material yellow. For this reason, where applicable UV stabilisers are added, or the surface is coated with a UV block (for example, the glass for car headlights). It is also sensitive to chemical attack, especially by bases, oxidising acids, methanol, aromatic chlorinated hydrocarbons and ammonium. A mild soap solution should be used for the maintenance/cleaning of shades, plastic end pieces and dust protectors. PC is also suitable for metallising.

PBT (polybutylene terephthalate)

PBT is a rigid material with good durability and chemical resistance. It also has good electrical properties, making PBT suitable for use as a lamp holder or body, etc. It can be used at higher temperatures, and fibreglass reinforced PBT provides even better heat resistance. PBT has good UV and weather resistance and also good sliding properties, which means it is often found in cars. The material is suitable for metallising. The above properties mean that PBT is suitable for products such as downlights, where high temperatures occur and there is a need for metallised reflective surfaces.

For more information go to www.barbourproductsearch.info

PMMA (Polymethyl methacrylate)

PMMA, also known under the trade name Plexiglas®, is acrylic plastic. It offers a very high light transmission and is, therefore, ideal for optical uses. It has a high degree of sheen on the surface and rigidity. PMMA is easy to shape, strong and offers limitless opportunities for colouring. PMMA is UV stable and has very good weather resistance, making it suitable for outdoor use. The electrical properties are also good. The material is not affected by alkaline solutions, diluted acids or oils, but is attacked by strong acids, acetone and alcohols. PMMA has relatively low heat resistance and should be used in situations where the temperature does not exceed 55 °C. It is possible to make PMMA more impact-resistant, but this is at the expense of its good optical properties. In the field of lighting, PMMA is normally used for shades and cover plates, as well as for outdoor signs, windows, contact lenses, etc.

PMMA is brittle, and where microscopic notches are present it can easily break. Just like PC, it is also sensitive to being under tension, which can lead to cracks forming over time.

Plexiglas® is a trademark of Röhm.

PS (Polystyrene)

Polystyrene has a high degree of stiffness and hardness. It has excellent optical properties and good dimensional tolerance. Other good properties are its high surface shine, low water absorption and excellent electrical properties. Among its disadvantages we can note poor impact resistance and low chemical resistance, especially to solvents. Polystyrene does not tolerate strong acids and dissolves in aromatic solvents. It also has low resistance to UV and turns rapidly yellow (3–6 months) when used in lighting products or outdoors. The highest temperature at which it can be used is limited to approx. 70 °C. The material is not authorised for lighting fittings for professional use, especially high powered ones or those with long burning times. The material is often chosen for domestic applications due to its low material costs.

PP (Polypropene)

Polypropene, also called Polypropylene, is one of the most common thermoplastics. The advantages of PP are its low density and high strength. Above all, PP has great fatigue strength, which makes it very suitable for hinge designs. The material can tolerate relatively high temperatures without losing its properties. Conversely, it copes less well at low temperatures, which means that in cold winter weather it is prone to becoming brittle and breaking. Another drawback of PP is that it is broken down by UV radiation unless stabilised with the help of additives. PP is used, among other places, in the end caps of luminaires.

PC/ABS

Sometimes, it is necessary to mix different plastics in order to obtain the properties required for the parts of the product. PC/ABS is one such combination of materials; it is rigid and has high tensile and bending strength and at the same time is impact resistant. The material is also dimensionally stable, with good weather resistance. It is customary to use PC/ABS where high demands are made for fittings, and at higher temperatures. The material is often used in electronics boxes, end pieces, instrument panels, etc.

Rubber

Rubber parts are most commonly found as packing material of various types. Normally, this is for sealing edges along the periphery of the luminaire against a glass disc, for instance. It is also found in insert seals for cables. More recently, plastic qualities (elastomers) which are reminiscent of rubber have taken over a number of these applications. They are cheaper to produce and can be made with greater precision. They also provide a more aesthetically pleasing surface than rubber.

EPDM rubber

Ozone and weather resistant. Good cold resistance. A certain resistance to oxidising acids and chemicals, animal and vegetable oils. Not resistant to mineral oils. Temperature range -40 °C to +100 °C.

Chloroprene rubber Neoprene (CR)

This material doesn't deteriorate over time with very good weather resistance. Good strength against oils, it expands in mineral oils but is not destroyed and offers very good mechanical properties. Found only in black mixtures. It crystallises at cold temperatures. Temperature range -20 °C to +100 °C.

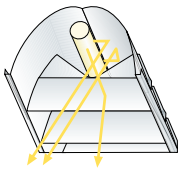
For more information go to www.barbourproductsearch.info

Reflector and louvre material

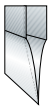
The reflectors and active louvres in the Fagerhult range are designed for maximum efficiency and controlled light distribution. This makes it possible to plan lighting for energy efficient solutions.

A significant factor in obtaining efficient luminaires is the choice of reflector and louvre material. Fagerhult carefully selects the best material available on the market.

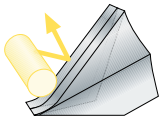
The louvres and reflectors fitted in Fagerhults T5 luminaires are constructed from the most effective aluminium available. Many products for T8 fluorescent lamps and compact fluorescent lamps come equipped with reflectors and louvres featuring highly reflective material. All done with improved energy efficiency and a lower environmental impact in mind.



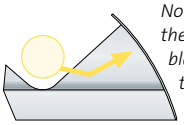
The r5 louvre effectively guides out the light even from the back of the fluorescent lamp.



Thin cross blades give larger light openings and increase efficiency.



Sealed top eliminates light loss.



No reflections from the top of the cross blades are visible in the side reflectors.

r5-louvres

Fagerhult's double parabolic r5-louvre has been developed for the T5-fluorescent lamp and gives the best effectiveness with regard to light distribution and efficiency. High efficiency is directly linked to energy efficiency.

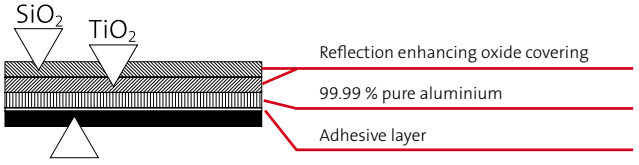
The r5-louvre consists of a double parabolic louvre and a top reflector, which maximises the optical efficiency and controls the luminance in all directions around the luminaire.

The r5-louvre has the following advantages:

- The reduction in the thickness of the cross-blades means that the light opening's area has been enlarged by approximately 4 %.
- Sealing the top of the cross-blades minimises light losses.
- The curved tops of the cross-blades eliminate unwanted reflections on the side reflector and gives good mechanical cut off in all directions.
- Metallised aluminium.
- Fixed top reflector of specular metallised aluminium.

The r5-louvre is available as r5, r5 mini and r5 micro.

Reflector technology



Aluminium of commercial standard

Advantages:

- Reflection factor up to 95 %.
- Reflection factor 10 % better than anodised aluminium.
- Better controlled beam path.
- Total lack of colour shifting on surfaces.
- Reduction in unwanted diffused beam path.
- The manufacturing process impacts less on the environment than anodising.

Beta
Double parabolic reflector louvre with side and cross-blades of satin matt metallised aluminium with excellent reflection characteristics (> 92 %), integrated into a single unit. The louvre remains attached when lowered. Earthed.

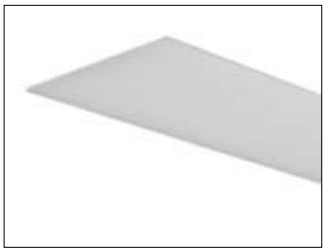
Gamma
Double parabolic reflector louvre with side and cross-blades of specular, metallised aluminium with excellent reflection characteristics (> 92 %), integrated into a single unit. The louvre remains attached when lowered. Earthed.

Terazza
Satin matt, metallised aluminium reflectors with excellent reflection characteristics (> 92 %) and aluminium enamelled cross-blades integrated into a single unit. The louvre remains attached when lowered. Earthed.

Texpo
Satin matt, metallised aluminium reflectors with excellent reflection characteristics (> 92 %) and white enamelled cross-blades integrated into a single unit. The louvre remains attached when lowered. Earthed.

Expo DP
Double parabolic reflector louvre with white enamelled side and cross-blades. Earthed.

Lamell
Lamell louvre of sheet steel.



Delta
Microprismatic acrylic louvre.

For more information go to www.barbourproductsearch.info

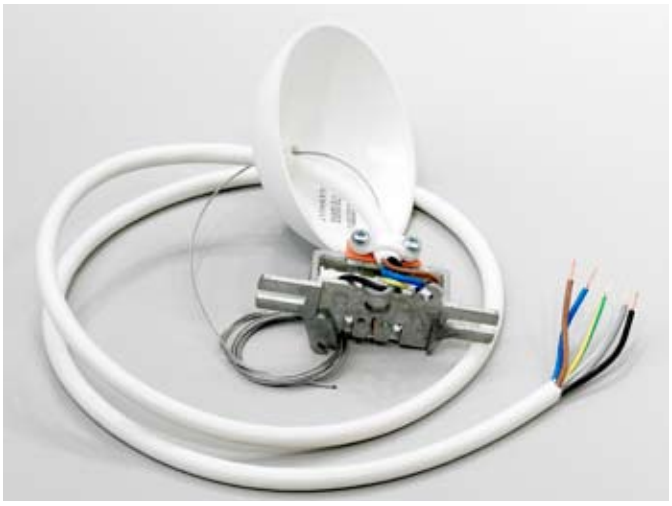
Many of our luminaires come with mains cables of varying designs fitted as standard. The design depends on the luminaire and its integrated functions, ranging from 3-core cables with plugs to open-ended 5-core cables with some form of snap-in connector, such as the Wieland.

For luminaires supplied without mains cables, we can offer a wide range of different mains cables, from simple 3-core cable racks with earthed plugs to various fixed connections. Our range includes cables in various lengths and designs, suitable for varying aesthetic or functional requirements. Fagerhult products are connected internally using PVC-free wire and the mains cable can also be supplied to order in a PVC-free design.

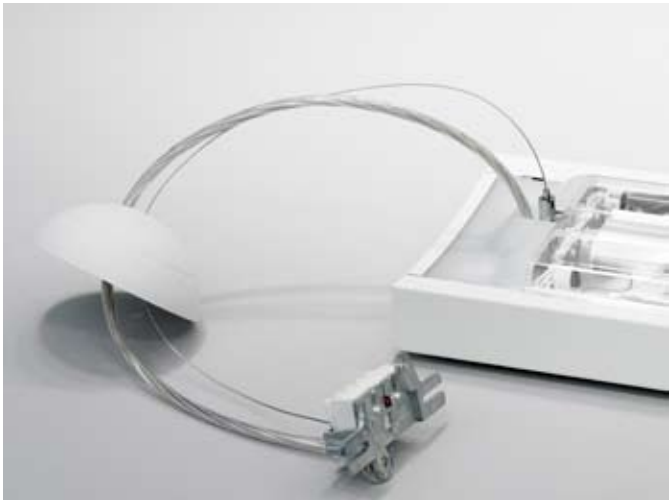
Transparent mains cables

We can also supply transparent 3-core and 5-core mains cables. These are more often than not chosen for aesthetic reasons. In order to pass approval, products with a transparent mains cable must be supplied fully connected by us because of the weak colour marking. This means we supply the luminaire with the mains cable connected both in the luminaire and the terminal block of the ceiling cup. The ceiling cup can be supplied in grey or white. The length of the mains cable should be specified when ordering. We have chosen to offer two lengths as standard, 400 and 1000 mm. In both cases, the length is ± 50 mm, depending on the location of the luminaire and terminal block. Note that transparent cables contain PVC.

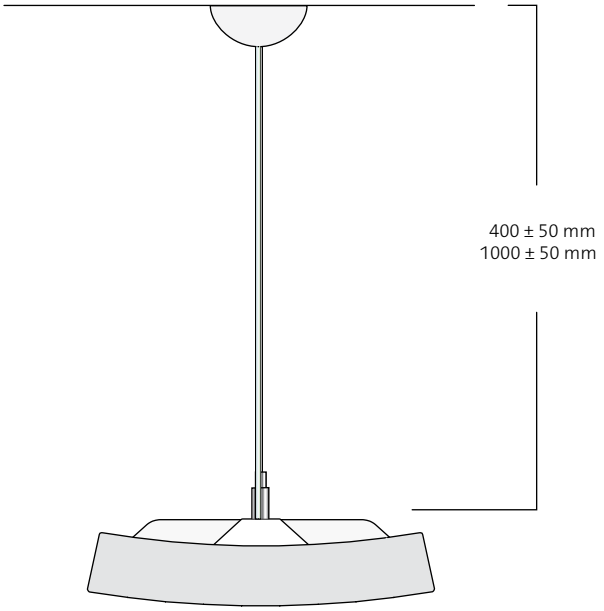
Read more about the properties of PVC on page 496.



Wire suspension with single wire, mains cable 5x1.0 mm² and ceiling cup for use together with luminaires having some form of external dimmer function.



For luminaires with a transparent mains cable, the connections in the luminaire and the terminal block of the ceiling cup are completed at the factory. Available as 3-core and 5-core with ceiling cup.



For more information go to www.barbourproductsearch.info

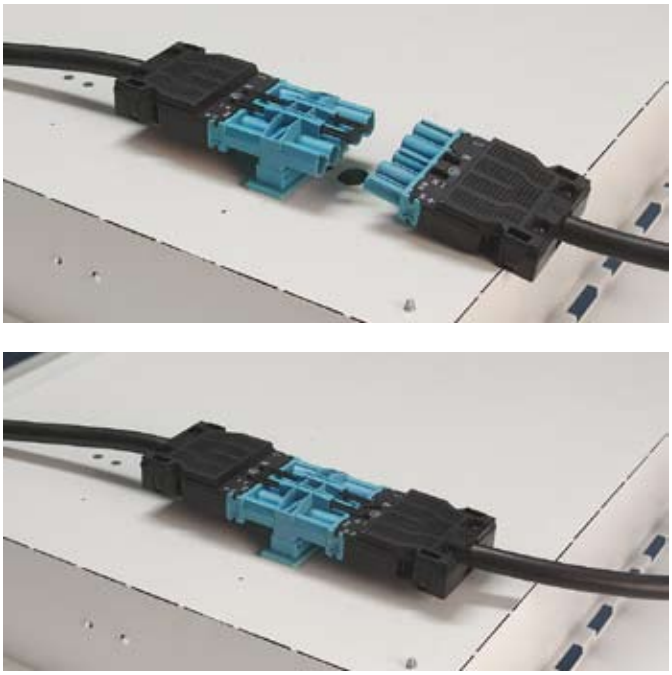
Quick connection system

Different makes and models of quick connectors can be used to simplify the installation of luminaires. The main benefit of quick connection systems is the reduction in installation times for large or continuous lighting systems. These systems allow a certain degree of flexibility, as it might be easier to move already-connected products without affecting the fixed installation.

In order to avoid incorrect connection that could, in a worst-case scenario, result in connected products becoming damaged or even dangerous, it is important for the quick connection systems available on the market to be used correctly, i.e. in the manner intended and designed for by the manufacturer. For example, a 5-way connector system intended for 3-phase installation must not be used instead for 1-phase + control cable for dimming. Other connector types must be used for such systems to prevent incorrect connection due to mistakes.

Fagerhult offers a range of products with integrated quick connectors. These connectors can either be chassis-mounted or the luminaire can be supplied with the cable and quick connector ready-fitted. All connectors are fitted with locking devices. For products with quick connectors, refer to the relevant product page.

Parts of our range can be supplied with Linect connectors, Linect is a new open standard that with use of interface connectors can be connected to different makes of quick connector systems.



Luminaire equipped with chassis connector and T-connector. Power and connection cables can be fastened after installation using plastic clips. A tool (e.g. screwdriver) is required to loosen the connectors.

Power cables	
	Wieland
1-phase system, 3-way connector.	
Length 2 m, female	**91789**
Length 2 m, female + earthed plug	**91790**
1-phase system + 5-way light-adjustment connector, blue	
Length 2 m, female	**91022**

Connection cables, quick connection system	
1-phase system, 3-way connector, white cable with white connectors, female + male, cable cross section 3×1.5 mm²	
Length 1 m	**91791**
Length 3 m	**91793**
1-phase system + light adjustment (1–10 V, SwitchDim/DSI, DALI), 5-way connectors, black cable with blue connectors, female + male, cable cross section 5×1.5 mm²	
Length 1 m	**91030**
Length 3 m	**91031**

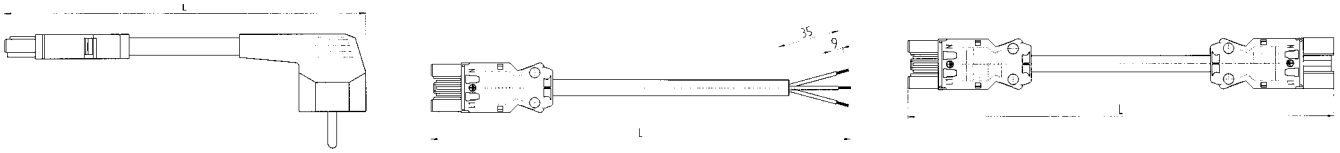
T-connector for branching directly to the chassis connector on the luminaire	
1-phase system, 3-way, white	**91025**
1-phase system + light adjustment (1–10 V, SwitchDim/DSI, DALI), 5-way, blue	**91026**

Connection cable.

T-connector.

Connection cable.

H-connector.



For more information go to www.barbourproductsearch.info

Luminaire's installation

Familiarise yourself with the supplied installation instructions and follow them during installation.

When testing the insulation of an installation, luminaires equipped with HF-ballasts should have the phase and neutral conductors interconnected. Measurement may only be made between the interconnected phase neutral conductors and the protective earth with maximum 500 V direct voltage. Once measuring is complete do not forget to disconnect the phase and neutral conductors before reconnecting these correctly to the terminal blocks.

Checklist of actions when the fluorescent lamp does not ignite or work correctly in luminaires with HF-ballasts:

1. Check that there is a voltage supply to the luminaire. Measure the supply voltage to confirm it is at the correct level. On a luminaire with a dimmable HF-ballast, also check the control voltage level, if applicable (analogue 1–10 V DC). Disconnect the control circuit and check whether the lamp ignites (100 %).
2. Always disconnect the voltage for safety reasons when making the following checks. On a luminaire with a dimmable HF-ballast even the control circuits should be disconnected.
3. Check that the fluorescent lamps wattage and type correspond with that on the luminaire label. Check that the HF-ballast type corresponds with the type stated on the luminaire label.
4. Check that the fluorescent lamp is fitted correctly in the lamp holders (that the fluorescent lamp has been turned and fully inserted in the right position). Check the lamp holders at the same time, making sure that the fluorescent lamp makes good contact (the holders should be well secured to the luminaire). If necessary remove dust, dirt, grease, etc.
5. Replace a fluorescent lamp that does not ignite with a new lamp that is known to work (even a new fluorescent lamp can be defective) and switch on the voltage. In 2-lamp luminaires both fluorescent lamps should be replaced using fluorescent lamps known to work.
6. If the fluorescent lamp does not ignite, switch off and check the cables for loose connections. Make sure there is no insulating layer between the connections' contact surfaces. Loose connections are usually evident through blackening or soot.
7. Disconnect the supply voltage to the control gear for about 20 seconds and switch it on again. The HF-ballast is generally designed to disconnect when it senses a defective fluorescent lamp or a break in the fluorescent lamp circuit (point 5). The situation is the same for the HF-ballast, if the fluorescent lamp has not been turned in the lamp holder, to the right position (point 4) or if there is a bad contact in the fluorescent lamp circuit (points 4 and 6). No HF-ballasts from any manufacturer can sense that a fluorescent lamp has been replaced with a new one without the voltage being disconnected and reinstated.

Cleaning luminaires

Luminaires should normally be cleaned in conjunction with re-lamping. Reflective surfaces ought to be cleaned when dust and other grime is discovered.

Electrical components or cabling must not be exposed to cleaning agent or water. It is important to always disconnect the voltage before cleaning the luminaire body.

We stock appropriate cleaning kits. These can be used on all materials, both for normal and heavy contamination.

A cleaning kit (Cat. no 94759) includes:

- 1 litre of concentrated general purpose cleaning agent (sufficient for about 200 litres of mixed solution).
- 6 general cleaning cloths for wet cleaning.
- 1 cleaning leather for wiping off.
- Cleaning instructions (can also be ordered separately from us).

What should be done if...

1. The fluorescent lamp does not ignite or the luminaire stays in standby mode?

- First check that there is a voltage supply to the luminaire and that there are no short circuits.
- Check that all the luminaire's fluorescent lamps are working.
- If the mains voltage is too low the fluorescent lamp will not ignite. Do not continuously under run a luminaire, as this can damage the HF-ballast.
- Component properties can change drastically in the cold, to a point where the HF-ballast no longer functions reliably. The fluorescent lamp doesn't ignite safely, or the HF-ballast immediately enters standby mode. Check the luminaire functions at room temperature.

2. The fluorescent lamp flashes, does not ignite or goes out haphazardly

- There is a fluorescent lamp in the luminaire with the wrong output or wrong HF-ballast.
- Continuous over voltage. Measure the luminaire's mains voltage.
- A conductor is disconnected or is loose. Check the connections.
- In cold surroundings both the HF-ballast's and the fluorescent lamp's properties change, to the point where the fluorescent lamp cannot continue to burn.
- Internal wiring between HF-ballasts and lamp holder too long.

3. The fluorescent lamp's cathode glows, but the lamp doesn't ignite

- Mains voltage too low. Measure the voltage on the luminaire.
- The starter in a luminaire with a conventional ballast could be defective.
- There is a fluorescent lamp in the luminaire with the wrong output/type or wrong HF-ballast.

4. The fluorescent lamp's ends darken or the cathodes flash

- Check that the fluorescent lamp is intact as set out in point 1.
- A conductor is disconnected or is loose. Check the connections as set out in point 1.
- It is recommended for some HF-ballasts intended for dimming, that the fluorescent lamp is burnt in for 100 hours before dimming is allowed.
- Note that it is perfectly normal for a fluorescent lamp's ends to darken after a long period of use, when it approaches the end of its normal service life.

5. There is a reduced fluorescent lamp life

- Is the luminaire switched on regularly during the day? A fluorescent lamp's nominal life span is based on a three hours burning interval (eight ignitions per day). If, with a conventional ballast you have significantly more ignitions, the fluorescent lamp's life span is shortened appreciably.
- There is a fluorescent lamp in the luminaire with the wrong output/type or wrong HF-ballast.
- A bad contact in the power circuit can shorten the life span of the fluorescent lamp.

6. The luminaire gives less light than normal

- The mains voltage is too low. Measure the voltage on the luminaire.
- When used in the cold the fluorescent lamps luminous efficacy decreases greatly, at the same time, the HF-ballast's properties change.

7. The earth-fault breaker or fuse trips when the lighting is igniting

- There could be an earth fault or short circuit in the luminaire group.
- Too many luminaires in the same circuit.
- A measurement instrument connected incorrectly to the power circuit can trip an earth-fault breaker.

8. There is a problem with the dimming system

- Always check before connecting that the luminaires are intended for the control unit used.
- Connections for 1–10 V control circuits are marked (+) and (-). Check the polarity.
- If the number of luminaires is large or the control circuit is long, a signal amplifier in the control circuit may be necessary. Control circuits for digitally controlled HF-ballasts have a maximum length of 250 m.

For more information go to www.barbourproductsearch.info

This symbol denotes the luminaire's light distribution, direct, direct/indirect, asymmetrical, round beam, etc. Several symbols next to the same luminaire indicate that the luminaire is available in different designs.

Denotes which light source/light sources that can be supplied with the luminaire. Several symbols next to the same luminaire indicate that the luminaire is available in different designs.

Denotes that the luminaire is designed for the T5-light source's unique characteristics. The small diameter of the fluorescent lamp has created new conditions for light control.

Denotes the luminaire's IP classification. If several figures are stated, the luminaire can also have a classification between these figures, or can be adapted to the higher classification. See also the table at the bottom of the page.

Class I
Appliances with functioning insulation. Equipped with an earth termination.

Class II
Appliance with double insulation. Complete insulation of all parts without earth termination. The appliance should be marked with the symbol.

Class III
For connection to low voltage via a separate transformer. The appliance should be marked with the symbol.

Signifies that the luminaire can be obtained in designs with emLED.

Signifies that the luminaire is available in designs for conventional emergency lighting operation.

Indicates the luminaire may be installed against materials that are normally combustible .

Indicates that the surface temperature of the luminaire is limited in accordance with the demands set out in EN 60598-2-24 (max. 90 °C on the luminaire's upward turned surfaces under normal operation).

t_a

States the maximum normal ambient temperature for the luminaire. Unless otherwise stated, 25 °C applies.

Labels on luminaires intended for temperatures exceeding 25 °C carry a separate t_a-marking stating the maximum temperature. The same applies to products only intended for outdoor use. Outdoor products can, for example, be marked t_a15 and therefore must not be installed in normal indoor environments.

T-, D- and higher t_a-markings can be found in the Fagerhult range, primarily only on products designed for environments with higher temperatures, for example, industrial luminaires.

It is in such areas that elevated t_a-marking may be required.

Note that a luminaire with a higher t_a-marking installed in a normal indoor environment cannot be considered to have a longer life compared to a luminaire intended for 25 °C. It is the design of the luminaire and the selection of the HF-ballast that affect its expected life span.

Consequently, t_a-marking has nothing to do with the expected life span of the ballast.

When Fagerhult develops products for elevated t_a-marking we apply the same temperature requirements as for products designed for normal room temperatures.

For more information about how Fagerhult works with assuring a good life span for ballasts please refer to the separate page.

Degree of protection (IP-classes)

Luminaires are given an IP-classification. The IP-classification consists of a two digit code that describes the degree of protection against solid objects as well as moisture and water. Standard luminaires will have an IP classification of IP 20 or higher. The table below describes respective IP-classifications. The IP-class is stated in plain text on the luminaire's label. Symbols as set out below can also be used in combination with the text. Note that IP 20 luminaires do not need to be marked. IP is an abbreviation of Ingress Protection.

Design according to first number	Design according to the second number						
	Unprotected	Drip proof	Rain proof	Splash proof	Jet proof	Water-tight	Submersible
Unprotected	IP 00	IP 01					
Protected	IP 10	IP 11	IP 13				
Protected	IP 20	IP 21	IP 23				
Protected	IP 40	IP 41	IP 43	IP 44	IP 45		
Dust-proof				IP 54	IP 55		
Dust-proof					IP 65	IP 67	IP 68

For more information go to www.barbourproductsearch.info

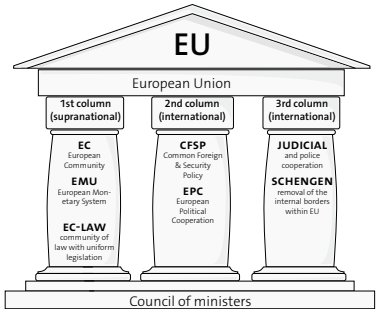
EC directive

An EC directive is binding for each member state it is directed to, but the member state may decide itself the form and procedure for implementation.

According to the EC treaty, directives can be adopted by the European Parliament and the Council, solely by the Council or by the Commission. Within the civil collaboration it is more common to use an ordinance than a directive. When an EC directive has been adopted it is to be implemented by each of the member states, that is to say, transformed into national legislation.

EU, laws and regulations

EU is sometimes illustrated as a building consisting of three columns. The columns make up the EU's different areas of cooperation and one of the reasons for the distinction is that the laws and regulations adopted by the EU work in different ways depending on which areas the regulations have their basis.



EU-structure

The first column, European community or the community column, embraces the larger part of cooperation within the EU. The laws and regulations that the member states adopt in this column are known as EC law and have their judicial basis in the EC treaty. It is primarily within EC law that the EC court may expound and judge.

According to the EC court, EC law shall apply before national law. This means that a national law that contravenes EC law shall not be applied. Included in EC law are:

1. The EC treaty and Euratom treaty in their applicable tenors.
2. Legal acts adopted by the EU institutions, for example, ordinances and directives.
3. Agreements between the EU and countries outside of the EU.
4. EC court's legal practice. The EC court determines in its judgements how EC law is to be expounded.

The EU can also adopt different types of legal acts within the second column, which includes the EU's cooperation concerning foreign and security policies, and the third column, which contains police and criminal cooperation.

Exactly as in the first column, some legal acts within these pillars can be legally binding for the member states. The member states are then obliged to follow and apply the legal acts. Other legal acts are solely politically binding and the member states are expected to observe them.

Common standards

Work to produce common European standards that specify the new method-directive's demands on health, safety and the environment is carried out by the European standardisation bodies CEN, Cenelec and ETSI.

CEN stands for Comité Européen de Normalisation, i.e. the European standardisation committee. CEN manages virtually all sectors within the industry. CEN, with its headquarters in Brussels, Belgium, has 27 member countries and six associated countries. Representatives from the European commission and Efta also participate in the work to draw up standards.

European standards:

EN 1837	Safety on machinery – Integral lighting of machines.
EN 1838	Emergency lighting.
EN 12193	Sports Lighting.
EN 12665	Basic terms and criteria for specifying lighting requirements.
EN 12464-1	Lighting of work places – Part 1: Indoor work places.
EN 13861	Safety of machinery – Guidance for application of ergonomics standards in design of machinery.
EN 13032-1	Measurement and presentation of photometric data of lamps and luminaires – Part 1: Measurement and file format.
EN 13032-2	Measurement and presentation of photometric data of lamps and luminaires – Part 2: Presentation of data for indoor and outdoor work places.
EN 13201-2	Road Lighting – Part 2: Performance requirements.
EN 13201-3	Road Lighting – Part 3: Calculation of performance.
EN 13201-4	Road Lighting – Part 4: Methods of measuring lighting.
EN 15193	Energy performance of Buildings – Energy requirements for lighting.

For more information go to www.barbourproductsearch.info

Directives concerning environmentally hazardous substances

The WEEE directive, the RoHS directive and the EuP directive

Environment and luminaires

For many years Fagerhult has taken the lead in technical development. As early as the end of the Eighties we developed lighting systems for HF-operation. In the middle of the Nineties we took the next step with the development of luminaires for the T5 fluorescent lamp. The T5 venture also presented the opportunity to develop more efficient reflectors and louvres.

Through advancements in component part technologies and our understanding of how to maximise them we can distribute light more efficiently. Through our work and our innovations we can contribute towards reduced energy consumption. 90 per cent of a lighting installation's environmental impact occurs during operation through the energy it consumes. Our contribution to tomorrow's environment is to develop more efficient luminaires. As market leader we take our responsibility seriously.

Despite our focus on energy, as a producer we still face demands about environment aspects concerning lighting products and component parts .

WEEE directive

The directive 2002/96/EC concerns WEEE (Waste Electrical and Electronic Equipment). The aim is for electrical and electronic products to be designed and manufactured in a manner so that waste is prevented and reuse and recycling are increased.

Manufacturers and importers shall pay for the recycling of the products and ensure that collection and environmentally correct recycling is carried out.

The WEEE directive comprises the following product categories:

1. Large household appliances.
2. Small household appliances.
3. IT and telecom equipment.
4. Domestic equipment.
5. Lighting equipment.
6. Electrical and electronic tools.
7. Toys and leisure and sports equipment.
8. Medical products.
9. Supervision and control instruments.
10. Vending machines.

What is included in Product category 5 – Lighting equipment:
Goods or equipment manufactured to normally be used:

- as a light source,
- to distribute or control lighting, or
- as a tool to distribute or control lighting.

The product category does not include luminaires manufactured for use in the home and incandescent lamps.

Fagerhult are a member of the Electrolink WEEE compliance scheme in the UK.

RoHS directive

Directive 2002/95/EC is also known as the RoHS directive (Restriction of the use of certain Hazardous Substances in electrical and electronic equipment). This directive prohibits the use of mercury, cadmium, lead, hexavalent chromium and flame retardants PBB and PBDE in electrical and electronic products released on the market from July 1, 2006. The products embraced by this directive are category 1 to 7 and 10 in the aforementioned WEEE directive

These acts are the first that seriously focus on the electronic industry's products. Of those substances banned by RoHS it is primarily lead that has required changes as this is found in most soldered joints, but also in many products.

Exemption

Exemption has been granted, for example, for mercury in fluorescent lamps and lead in optic glass. Batteries are embraced by a specific directive. Furthermore, spare parts intended for the repair of electrical and electronic products that have been released on to the market before July 1, 2006 are not included. Products that are a part of a product not embraced by the WEEE directive are not included in the demands of the RoHS directive.

How does Fagerhult conform to the requirements in RoHS?

Our purchasers have asked our suppliers and received written assurances from them. We have also scrapped old outgoing models of HF-ballasts.

For more information go to www.barbourproductsearch.info

EuP directive

Directive 2005/32/EC, the EuP (Energy Using Products) directive, was adopted on the 6th July 2005 and constitutes the framework for drawing up the requirement specifications within Ecodesign for energy using products.

This directive applies, among other things, to electrical and electronic products and will be implemented in the previous directives, WEEE and RoHS. The directive covers all products that require energy for their function with the exception of means of transport for people and goods.

The intention of the EuP directive is to force industry to design the products of tomorrow to consume less energy, both during manufacture and their life cycle.

In Sweden, the Eco-Design Act came into force on 1 May 2008. The Act means that manufacturers must take energy use and other environmental factors into consideration when designing and producing the product. Products that do not meet the requirements will not qualify for the CE label and cannot be marketed within the EU. Until now, product requirements have been voted through in the Regulatory Committee (representatives from the affected authorities in the various EU countries) regarding the following:

- Standby power.
- Street and office lighting.
- Simple digital boxes.
- External mains power units.
- Domestic lighting.

Once the proposals have been voted through on the Regulatory Committee, the proposal is forwarded to the EU parliament (Council of Ministers), who may approve or reject the proposal. It is expected that this will happen before the end of February 2009.
For domestic lighting (EuP – regulation on domestic lighting products) the following was voted through on the Regulatory Committee on 8 December 2008:

Stage 1 – 1 September 2009

- All clear incandescent bulbs > 950 lm (≈ 80 W) and all non-clear incandescent bulbs are to be phased out. Clear bulbs are to be replaced by Energy Class C bulbs. Frosted bulbs are to be replaced by Energy Class A bulbs.

Stage 2 – 1 September 2010

- All clear incandescent bulbs > 725 lm (≈ 65 W) are to be phased out and replaced by Energy Class C bulbs.

Stage 3 – 1 September 2011

- All clear incandescent bulbs > 450 lm (≈ 45 W) are to be phased out and replaced by Energy Class C bulbs.

Stage 4 – 1 September 2012

- All clear incandescent bulbs > 60 lm (≈ 7 W) are to be phased out and replaced by Energy Class C bulbs.

Stage 5 – 1 September 2013

- Increased quality requirements.

Review

- It is expected that there will be a review of the requirements in 2014.

Stage 6 – 1 September 2016.

- All clear incandescent bulbs > 60 lm (≈ 7 W) are to be phased out and replaced by Energy Class B bulbs.

At the start of 2009 a proposal had been voted through in the Regulatory Committee for products within the professional lighting industry – street and office lighting. This (EuP – *regulation on tertiary sector lighting products*) was taken up by the EU parliament and is based on three steps. The proposal relates to ecodesign requirements for fluorescent lamps without an integrated ballast, high pressure discharge lamps and drive units and luminaires for these light sources.

Stage 1 – one year after implementation (2010)

- For light sources, T8 halophosphate fluorescent lamps and fluorescent lamps (T8 and T5) with a colour rendering index < Ra 80 will be phased out. In addition, the manufacturer must supply product information about high pressure discharge lamps and fluorescent lamps online and in the technical documentation.
- Ballasts – a mandatory EEI (Energy Efficiency Index) label must be placed on all fluorescent lamp ballasts. Ballasts included in table 16 must comply with at least EEI class B2. Those not included in table 16 must comply with EEI class A3. The standby power of fluorescent lamp ballasts must be less than 1 W.
- Luminaires – 18 months after stage 1 comes into force (the second half of 2010), the mandatory information regarding the contents of luminaires for fluorescent lamps and high pressure discharge light sources (> 2000 lumen) must be available online and in the product documentation. The information must also include maintenance instructions and directions for the removal of scrap products for recycling. In addition, the same standby limits apply to luminaires as to ballasts.

Stage 2 – three years after implementation (2012).

- Light sources – T10 and T12 halophosphate fluorescent lamps are to be phased out. Other light sources to be phased out are the least efficient high pressure sodium and metal halogen light sources (with E27, E40 and PGZ12 sockets). Five years after this comes into force (2015), mercury light sources will also be phased out.
- Introduction of minimum ballast efficiency requirements for ballasts for high pressure discharge lamps. In addition, mandatory EEI (Energy Efficiency Index) labelling is being introduced on all ballasts. The standby power of fluorescent lamp ballasts must be less than 0.5 W.
- Luminaires – the requirement is that luminaires with integrated ballasts must be compatible with the third stage requirements for ballasts, except in luminaires with an encapsulation class of at least IP 4X. The mandatory information for all luminaires must be available online and in the product documentation. In addition, the same standby limits apply to luminaires as to ballasts.

Stage 3 – taken eight years after implementation (2017).

- As far as light sources are concerned, the majority of metal halogen light sources are to be phased out (≥ 405 W with sockets E27, E40 and PGZ12). 2-pin compact fluorescent lamps are also being phased out.
- Ballasts – class B1, B2 and A3 ballasts for fluorescent lamps are being phased out. In addition, there are requirements for the efficiency of the ballast, depending on the power of the light source.
- Luminaires with ballasts must meet the third stage requirements for ballasts.

For more information go to www.barbourproductsearch.info

On January 4, 2006 a new EU directive – Energy Performance of Buildings, 2002/91/EC (EC stands for European Communities) came into force. The directive means buildings must be declared with regard to the total energy consumption. The building's energy consumption must be calculated and declared in advance and applies to all energy consumption – lighting, heating, cooling, ventilation, etc.

The aim is to promote an improvement in the energy performance in buildings within the EU and in doing so reduce the discharge of climate-influencing gases, exactly as stated in the Kyoto agreement. At the same time a reduction in the use of energy is also sought.

The directive has been drawn up to promote improvements related to energy performance at the same time as local conditions are taken into consideration. Southern Europe does not face the same conditions as the Northern Europe.

The directive has the aim to improve the efficiency of energy usage in Europe as a part of the EU's measures to satisfy the Kyoto Agreement concerning the reduction of greenhouse gases.

In England and Wales the implementation of the directive started in April 2006 with the amendment to Part L of the building regulations. Further amendments are set to come into force in October 2010.

The EC directive means that "all" properties are to be declared with regard to energy consumption. An implementation time up to 2009

is expected on account of the need to train inspectors. The directive stipulates that affected buildings will be classified and consideration must be taken of all types of energy, daylight, ventilation etc. The directive necessitates that consideration must be paid to how the installed output is used over time with the value to be declared in kWh/m² per year. The factors to be included in the calculation are stated in the directive's annex, while section 1(e) as follows: "Inbuilt lighting installations (primarily the sector that is not intended for residential purposes)". When planning a lighting scheme efficient energy usage over time and the use of controls must be considered in addition to the visual performance of the lighting.

Energy Usage Declaration

The EC directive stipulates what is to be done. A declaration of energy usage must be made for buildings within the EU.

Demands are established in the directive concerning:

- The general framework for a calculation methodology for the buildings' integrated energy performance.
- Implementation of minimum requirements for the energy performance of new buildings.
- The implementation of minimum requirements for the energy performance in existing large buildings that undergo major renovation.
- Energy declaration (certification) of buildings.
- Regular control of boilers and air conditioning systems in buildings and an evaluation of heating installations if the boilers in it are older than 15 years.

The energy declaration is only a part of what the directive decrees, yet it is the part that has the greatest effect on the property owners. The law states that all owners of buildings are obliged to draw up an energy declaration when a building is built, sold, rented or transferred. A declaration is valid for ten years and must be drawn up by accredited energy experts appointed by the building owner. This includes data about energy consumption, reference values and recommendations about how the building's energy usage can be made more efficient.

In the annex to the Directive it cites the importance of applying positive factors, which should be used where possible, for example in the instance of lighting the addition of natural light. When calculating energy usage, consideration should also be paid to the outdoor climate, local conditions, the demands on the indoor climate (e.g. EN 12464-1) and cost efficiency.

Exemption

The member states may decide themselves to exempt buildings with official protection as a part of a selected environment. They can also be exempted on account of their special architectural or historical value if the demands result in unacceptable changes to their distinctive features or appearance. Exemptions can also be given to churches or other buildings used for spiritual and religious activities.

Other buildings not included are temporary buildings (intended to be used for two years or less), industries, workshops and agricultural buildings with a low energy requirement that are not intended as dwellings and which are used within a sector not encompassed by a national sector agreement concerning energy performance.

Single family houses (weekend cottages or residential properties) intended for use less than four months per year or freestanding buildings with an overall usable floor area of less than 50 m² are also exempt.

For more information go to www.barbourproductsearch.info

The standard EN 15193

Common standards are created to produce common calculation methodology. Different standards are drawn up to calculate the different energy consumers in the building.

Naturally lighting is included as an important part of the energy usage in a building. Standard EN 15193, *Energy performance of Buildings* – Energy requirements for lighting, describes a harmonised method of calculating energy usage for interior lighting. The lighting's energy efficiency in the building must be evaluated with an index; Lighting Energy Numeric Indicator (LENI) and is expressed in kWh/m² per year.

The LENI-number must be shown for the entire building and can be used to compare the energy expended on lighting. The comparison can be made between different buildings with the same function but of a different size and design.

The standard will provide example values of the LENI number for a number of common building types, thus shifting the focus from the installed output to how the energy in used over time.

The indicator for the energy efficiency of the lighting

The energy consumption for lighting must be declared via the an Lighting Energy Numeric Indicator (LENI) and is expressed in kWh/m², year.

LENI is calculated on the lighting for the entire building. At the same time the lighting shall conform to current standards and recommendations for indoor lighting (EN 12464-1).

W_{total} is the total annual energy usage for lighting.

A is the building's total interior area (m²).
The area is calculated inside the external walls excluding non-used cellar areas and unlit rooms.

The calculation of the LENI number for the building is performed using the formula: $\mathbf{LENI}_{calculated} = \mathbf{W}_{total} / \mathbf{A}$ (kWh/m², year)

The LENI number can be calculated in two different ways, a quick and a comprehensive

The quick method

This method is used to give an estimate of the building's annual energy usage, applicable for just a number of common building types. The standard includes tables where the annual standard data for different types of buildings can be read to aid calculation via the quick method. These are offices, buildings for tuition, hospitals, hotel, restaurants, sports centres, department stores and retail shops and manufacturing industries.

The quick method also includes a standard value for the parasitic energy ($W_{parasitic}$) which is stated as 6 kWh/m² a year and which should be used when applicable. It is distributed over 1 kWh/m² year for charging emergency lighting and 5 kWh/m² year for standby energy for the ballast.

$\mathbf{LENI} = \mathbf{W}_{light} + \mathbf{W}_{parasitic} / \mathbf{A}$ (kWh/m², year)

The comprehensive method

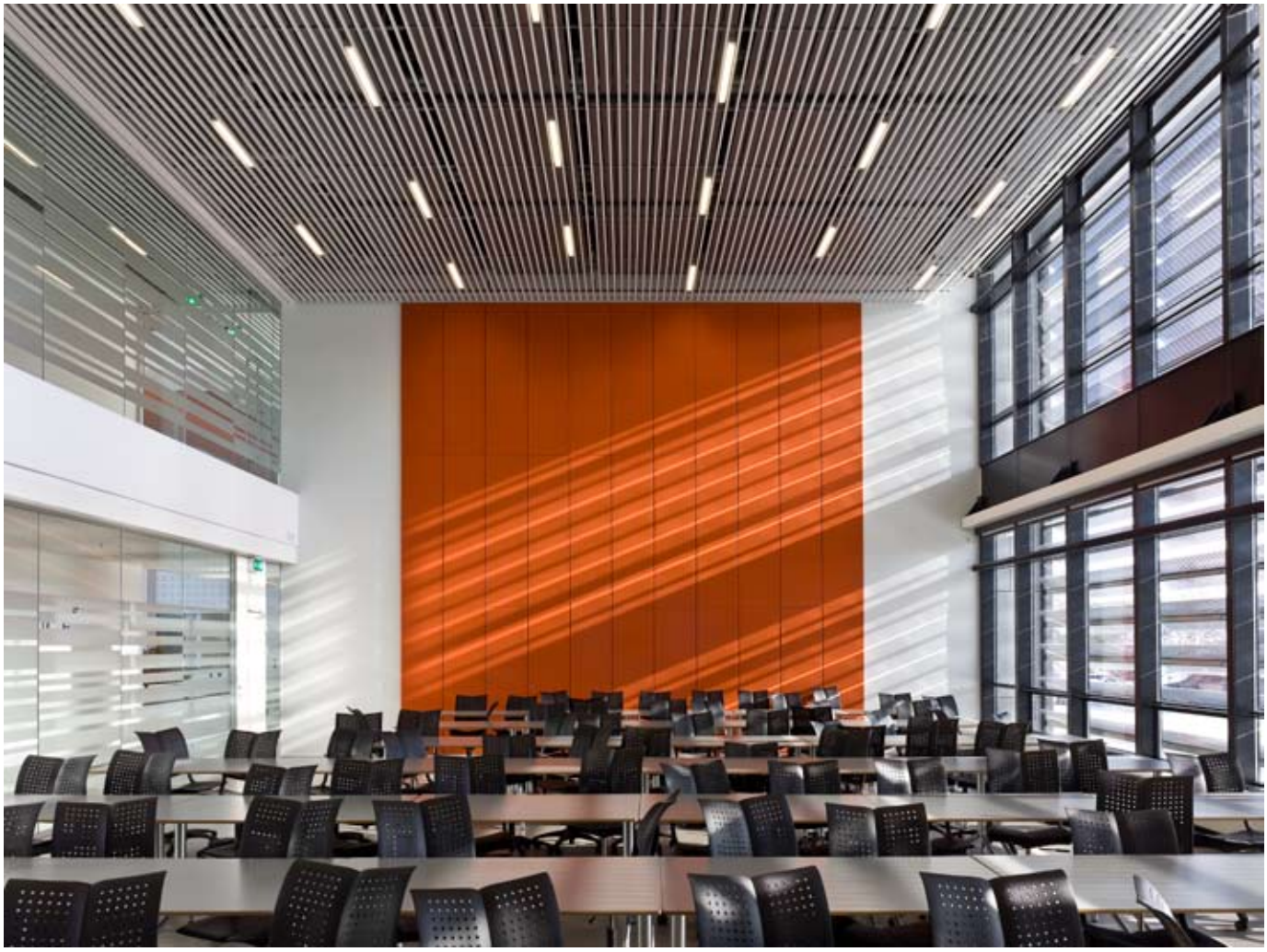
This method permits an exact determination of the energy used as the method is based on actual values for each room. Unlike the quick method, the comprehensive method can be used for all types of buildings, even at different geographical positions. As the comprehensive method is based on actual values it gives a lower LENI number than a calculation with the quick method. Calculations provided by Fagerhult, and those via DIALux, are based on the comprehensive method.

Using the comprehensive method you can calculate for a selected period (not only the whole year) under the condition that you can get an estimation of the presence and availability of daylight. In the examples on the coming pages we have used the comprehensive method.

$\mathbf{LENI} = \mathbf{W}_{light} + \mathbf{W}_{parasitic} / \mathbf{A}$ (kWh/m², time*)

** Using the comprehensive method you can calculate on an annual, monthly or time basis.*

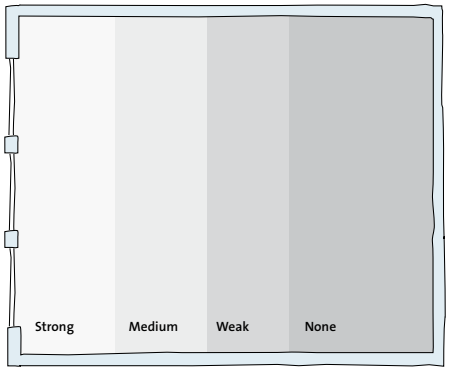
For more information go to www.barbourproductsearch.info

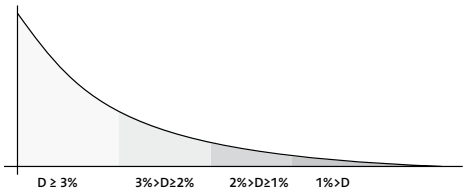


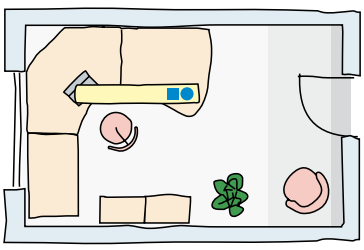
Availability of daylight

Daylight must be included within the calculations to give a correct value. The availability of daylight divides the room into different zones. The different zones describe a specific daylight interval, divided by a daylight factor: *Strong, Medium, Weak* or *None*. Luminaires located in the stronger zone can utilise a larger devaluation of the utilisation, which reduces the total power consumption. The daylight factor is obtained by making a light measurement of indoor illuminance and expressing the measurement result as a relation to the outdoor illuminance at the same time.

The formula becomes $D(\%) = E_{indoors} \times 100 / E_{outdoors}$







The room contains zones with different daylight intervals. The availability of daylight is dependent on the room's glazed area and window placement. In this room there are potential savings of over 60 % with the use of daylight and absence control.

For more information go to www.barbourproductsearch.info

The total energy consumed for lighting is calculated according to the formula and is stated kWh/year:

$$W_{total} = W_{light} + W_{parasitic}$$

W_{light} is the estimated energy consumption used to power the lighting in the building during a given period. All light sources and ballasts included.

$W_{parasitic}$ is the estimated energy used when the lighting is extinguished. That is to say, the energy used by the ballast in standby mode or for charging emergency luminaires.

Which factors affect the lighting's output in operation, W_{light}?

W_{light} is affected by the following factors

P_n is the total installed lighting output within a room or zone, measured in watts ($P_n = \sum P_i$).

F_C is a correction factor for constant illuminance in a room or a zone.
F_C is affected by:
- Maintenance factor (β).
- Maintenance plan.

When constant light control is used:
F_C=(1+maintenance factor)/2, otherwise the standard value 0.9 is used.

F_D is a correction factor for daylight. F_D relates use of the total lighting output to the availability of daylight in the building.

F_D is affected by:
- The daylight factor (amount of daylight).
- Illuminance.
- Type of control.

F_O is a correction factor depending on presence. F_O relates use of the total lighting output to the presence time in the building.
F_O is affected by:
- Presence/absence.
- The type of control.
- Total utilisation time (t tot) day+night (t_N+t_D).

The formula to calculate the energy consumption:

$$\mathbf{W_{light} = [\sum(P_n x F_C) \times [(t_D \times F_D \times F_O) + (t_N \times F_O)]] / 1000} \text{ (kWh/year)}$$

Which factors affect the lighting's output when it is extinguished, $W_{parasitic}$?

$W_{parasitic}$ is affected by the following factors

Emergency lighting system

P_{em} charging power for emergency lightingwithin the building.

t_{em} is the charging time for emergency lighting (standard value for t_{em} is 8760 h/year).

Control system

$P_{light\text{-}off}$ parasitic "standby" power for control equipment when the lighting is in the "off position".

$t_{light\text{-}off}$ when the lighting is in the "off position" [$t_Y - (t_D + t_N)$] (standard value for t_Y is 8760 h/year).

The formula to calculate the parasitic energy:

$$\mathbf{W_{parasitic} = [\sum P_{pc,\ Light\text{-}off} \times t_{Light\text{-}off} + (P_{em} \times t_{em})] / 1000} \text{ (kWh/year)}$$

For more information go to www.barbourproductsearch.info

Quantity/Concept	Symbol	Unit	Formula	Explanation
Luminous intensity	I	candela (cd)	I=Φ/ω	Luminous intensity is the intensity in a determined direction. Definition: Luminous flux per solid angle (ω). Definition: Luminous flux per solid angel (ω)
Illuminance	E (lx)	Lux (lm/m²)		Illuminance refers to the luminous flux that hits a specific surface. Definition: Luminous flux per unit area (m²).
Luminance (luminous intensity)	L	(cd/m²)	L=I/A (L=I/Acosα)	This is defined as the luminous intensity in a specific direction from a surface of a light source, luminaire or lit surface, divided by the projected area.
Luminous flux	Φ	lumen (lm)	Φ=I/ω	Luminous flux refers to the total amount of light emitted from a light source. It is defined as the amount of light emitted when the light source's radiant luminous flux, is evaluated against the eye's sensitivity in daylight (V_λ-curve according to CIE).
Design lumen	Φ_B	lumen		Refers to the light source's luminous flux that is emitted at an ambient temperature of 25 °C. The quoted luminous flux may differ from the light source's maximum luminous flux. (For example T5-fluorescent lamp).
Light Output Ratio (LOR)	η_A			Ratio between the total flux from the luminaire, measured under specified practical conditions with its own light sources and equipment, and the total individual luminous flux from the same light sources operating outside the luminaire using the same equipment, under specified conditions
Design efficiency	η_B			The design efficiency of the luminaire is used in lighting calculations together with the design lumen for the light source. The design efficiency includes the correction for BLF when measuring the luminaire and light source in an ambient temperature of 25 °C. $\eta_B = \eta_{measured}$ x BLF.
Ballast Lumen Factor	BLF	–	–	Defines the luminous flux from a light source. It is measured with either a commercial ballast or a reference ballast, at an ambient temperature of 25 °C.
Colour temperature	–	kelvin (K)	CIE 17.4	The colour temperature is defined using absolute temperature. (0 K = -273.15 °C or 0 °C = +273.15 K)
Colour reproduction index	Ra	Ra-index	CIE 17.4	Is the measurement of a light source's ability to reproduce colour compared to a reference light source at a predetermined colour temperature. An Ra index is used for graduation, which according to CIE, can be at the most 100 and shall for lighting workplaces be a minimum of 80.
Luminous efficacy – light source	H	(lm/W)	η=Φ/P	The luminous efficacy from a light source can be defined as the relationship between the luminous flux emitted by a light source and the electrical output it consumes. Luminous efficacy can also be described as a measurement of light source efficiency.
Luminous efficacy – system (light source + ballast)	H	(lm/W)	η=Φ/P	The system luminous efficacy from a light source can be defined as the relationship between the luminous flux emitted by a light source and the electrical output it consumes including ballast losses.
Glare			CIE- 31, 112, 117	Is a visual impairment caused by the extreme contrast or inappropriate distribution of luminance levels. Glare is normally subdivided into: -discomfort glare UGR/NB – disability glare TI/GR.
Uniformity – illuminance – luminance			E_{min}/E_{ave} L_{min}/L_{ave}	Ratio between the lowest value and the average value of brightness on a specific surface unless otherwise stated.
Luminaire luminance		–	–	The average luminance of a luminaire's luminous parts measured and/or calculated in the C-plane at 15° intervals starting at 0°, and elevation angles (γ) of 65°, 75° and 85°.
Shielding angle for luminaire's light source		–	–	The angle between the horizontal plane and the first line of sight at which any part of the luminaires light source becomes directly visible.
Cut-off angle for luminaires		–	–	Angle, measured upwards from nadir, between the vertical axis and the first line of vision at which the light sources and surfaces with high luminance are not visible.
Solid angle	ω	steradian (sr)	ω=A/r²	The relationship between the cut out area A on a sphere caused by a beam of light on its surface and the square of the spheres radius r.
Mean mortality rate – for light sources	–	hour (h)	–	Mean mortality rate is the average life span of a light source and is defined as the time after which 50 % of a large number of controlled light sources have failed (Incandescent lamps, halogen lamps and fluorescent lamps).
Service mortality rate – for light sources	–	hour (h)	–	The service mortality rate is defined as the point at which 80 % of the lighting installation's original luminous flux remains. The depreciation in luminous flux depends on the reduced luminous flux and spent light sources.
Economic mortality rate – for light sources	–	hour (h)	–	The economic mortality rate is defined as the point at which 70 % of the lighting installation's original luminous flux remains. The depreciation in luminous flux depends on the reduced luminous flux and spent light sources.

For standardised definitions and further clarification of magnitudes, units and concepts, see EN 12 665 – Basic terms and criteria for specifying lighting requirements. (EN 12 665 – Basic terms and criteria for specifying lighting requirements).

For more information go to www.barbourproductsearch.info

Planning the lighting of indoor workplaces

From May 2003 companies in European CEN-countries, have a mutual standard for the planning of lighting of indoor workplaces.

The standard EN 12464-1:2002 – Lighting of work places – Part 1, has been developed by the technical committee CEN/TC 169 "Light and Lighting".

EN 12464-1 applies to the following countries : Belgium, Bulgaria, Cyprus, Denmark, Estonia, Finland, France, Greece, Hungary, Ireland, Iceland, Italy, Latvia, Lithuania, Luxembourg, Malta, The Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Switzerland, Spain, United Kingdom, Sweden, The Czech Republic, Germany and Austria.

Lighting of indoor workplaces

The following text is an interpretation of the main guidelines in the European standard for the lighting of indoor workplaces EN 12464-1.

The standard does not cover all aspects of planning a lighting installation, and reference should also be made to the SLL code for lighting.

Workplace lighting

The European standard EN 12464-1 highlights the minimum illuminance requirements of an actual working area rather than the entire room. The guidelines recommend that the lighting outside the working area should be adapted to the conditions that apply inside the working area. The values stated in the collection of tables, refer to the lowest illuminances in the workspace of a visual object, that can be either horizontal, vertical or placed at an angle. The illuminances documented consider the lowest average values for working under normal conditions. However, the illuminances can be adjusted by the increments set out below if the visual conditions deviate from the normal conditions.

20–30–50–75–150–200–300–500–750–1000–1500–2000–3000–5000 lx

The demands on illuminances used in the workplace, should be regularly reviewed to overcome the following situations; difficult working conditions, activities that demand great accuracy or high productivity, impairment of visual efficiency, viewing objects with fine detail or in low contrasts of light or the use of DSE terminals for long periods of time.

In practice, the specified illumination can be reduced under the following conditions; when visual objects have an abnormally large size and high contrast or when visual work is in progress for short periods.

In workplaces with continuous occupancy the illuminance must not drop below 200 lx. Continuous occupancy refers to work that is performed for more than two hours.

The recommended values assume that the employees have normal sight. If a greater number of people have some form of sight impairment, this should be taken into consideration when designing a lighting installation.

Lighting the visual object

The main principle is that the light falls in such a manner that the greatest possible contrast is placed on the visual object, which may have a horizontal, vertical or sloping position. It can also consist of varied structures or have different combinations of surface characteristics, matt, bright etc,resulting in varied reflective characteristics.

A basic prerequisite for good visual comfort in the workplace, is that the work object's position and shape, in relation to the direction of light, does not cause any form of unpleasant glare or glare that impairs the vision e.g. dazzling luminaires or disturbing reflections.

For more information go to www.barbourproductsearch.info

Principles for establishing the working area and surrounding calculation surfaces

Lighting of the working area

The working area is defined, according to EN 12464-1, as the area of the workplace where tasks are performed. For areas where the size and/or placement of the working area is unknown, the area where the tasks may be performed is to be considered as the working area

The working area is usually made up of the entire workplace/ workstation. For example, in an office workplace, the working area is made up of a small surface where paper work is carried out. Work with a monitor and keyboard usually demands a lower illuminance than when paper work is performed. The illuminance level needs to be adjustable for work with monitors and to help achieve a suitable balance with the surrounding area. Adjust relative to the surrounding areas illuminance.

In an office where paper work is carried out the workspace can be made up of an entire work table. In industry, the size of the working area can be harder to define e.g. workplaces for work involving microelectronics or a production line for assembling cars.

When the exact size of the working area is unknown, it is normally taken as 0.6 mx0.6 m for an office workplace. In this case the working area is thought to be located directly in front of the person's normal position and at the front edge of the desk. The variation of the illuminance, i.e. the ratio between the lowest illuminance in relation to the average illuminance on the working area, should be as small as possible and not fall below 0.7.

Lighting of the immediate surroundings

The lighting of the immediate surrounding area should relate to the lighting level within the working area and in addition create the conditions for a well-balanced luminance distribution within the normal field of vision. Extensive changes to the lighting level around the working area can cause visual stress and discomfort.

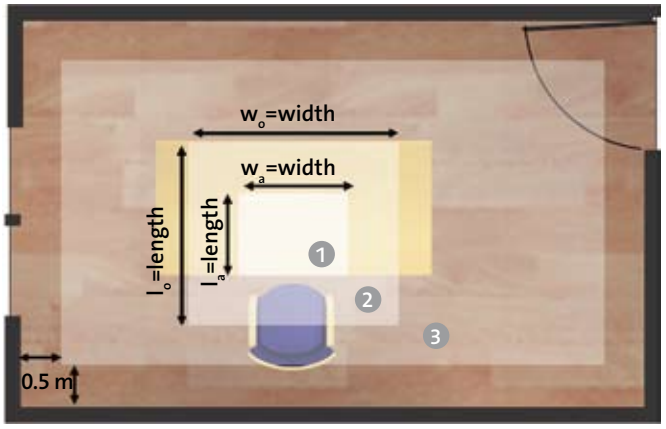
The immediate surrounding area is defined as an area around the working area with a width of at least 0.5 m. The size of the immediate surroundings should be determined by the planner and may need to be increased to a width greater than 0.5 m, for specific types of workplaces.

The size of the immediate surroundings can be increased:
- When the size of the working area is small.
- If the illuminance within the working area is high.
- With active work.

The illuminance in the immediate surrounding area can be lower than within the working area, but should not fall below the values stated in the table to the right.

The variation of the illuminance, i.e. the ratio between the lowest illuminance in relation to the average illuminance in the immediate surroundings, should be as small as possible and not fall below 0.5.

Example of the workspace for a typical workplace.



1. Working area (l_a x w_a)
– size and position are established by the lightplanner.

2. Immediate Surrounding area (l_o x w_o)
– The size to be established by the light planner. (l_a+2 x ≥ 0.5 m) x (W_a+2 x ≥ 0.5 m).

3.Outer surrounding area
– 0.5 metres from the room's walls.

Lighting of the peripheral surroundings

There are no defined demands on the illuminance within the peripheral surrounding areas in the EN 12464-1, i.e. the area outside of the immediate surrounding area. This area is defined as the area outside the surrounding areas, to a distance of 0.5 m from the room's walls.

However, within a workroom the relation between the illuminance on the working area and the lowest illuminance in the workroom in the zones where there are no workplaces, should not exceed 5:1. For example, circulation areas.

If, for example, demands on the illuminance within the working area are 500 lx on the workplace, the lowest illuminance in the premises should not fall below 100 lx. The lowest illuminance is calculated within a zone outside of the immediate surroundings, to half a metre (0.5) from the room's walls.

Uniformity within the peripheral surroundings should not fall below 0.5. The lighting around the working area should contribute towards good visual adaptation, as recommended in the luminance distribution and luminance limitations section of the report.

As a rule in work areas with bright walls, the relation between the illuminance within the working area and the average illuminance on the rooms walls should not exceed 3:1.

Relations between different illuminances and uniformity demands

Illuminance within the working area	Illuminance within the immediate surroundings
≥ 750	500
500	300
300	200
≥ 200	$E_{uniformity}$
E_{min}/E_{ave} ≥ 0.7	E_{min}/E_{ave} ≥ 0.5

Table of uniformity demands and the relation between illuminances within the immediate surroundings of the working area.

For more information go to www.barbourproductsearch.info

Glare

Glare occurs when part of an interior space is significantly brighter than the room's luminosity. In these instances the eyes are exposed to a more intense light than they are normally adapted to. The most common cause of glare occurs when the luminaire and window can be seen directly or via reflections, within the normal field of vision.

Elderly people are usually more irritated by glare than young people. This is mainly due to the increased clouding of the eyes lens experienced with age as well as a reduction in the ability to adapt.

Glare can be divided into two different types; disability glare and discomfort glare.

Sight impairment glare and discomfort glare can occur simultaneously or separately.

Disability glare

Disability glare usually occurs when an object in the vicinity of the normal line of sight, has a significantly higher luminosity or luminance than that which usually occurs in the field of vision. If an eye is exposed to a continuous intense light, the eye's adaptation can be affected negatively and cause deterioration in visibility, or what is known as contrast reduction.

This contrast reduction can be sufficient to make words and images barely visible and in doing so make it difficult to carry out the visual task. Alternatively, if the light source causing the glare is directly in the line of sight this can cause noticeable after-images. The most common source of sight impairment glare internally, is the sun and sky viewed from a window or a badly shielded light source observed directly or via reflection.

Disability glare should therefore be prevented through using luminaires that effectively shield the light source (see table).

Lowest shielding angle for the light source's luminance

Light source's luminance [kcd/m²]	Minimum shielding angle
20 to < 50	15°
50 to < 500	20°
≥ 500	30°

The values in the table do not include indirect luminaires or luminaires that are installed below normal eye level.

Calculation of the glare index

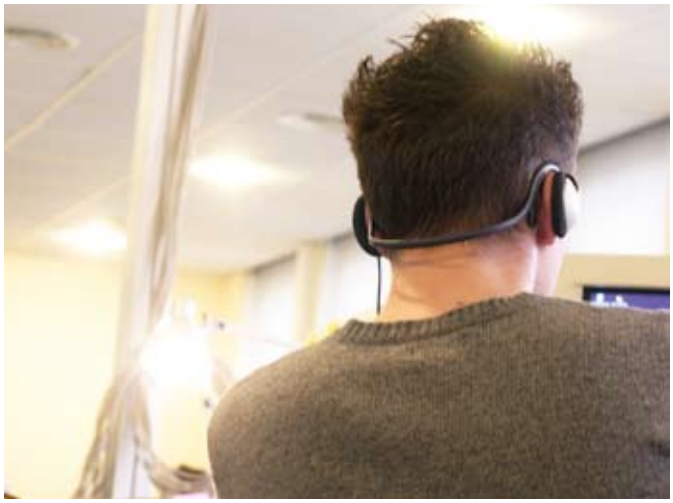
The degree of discomfort glare for indoor installations can be estimated by calculating the glare index according to the UGR method. The method will, through the introduction of the new standard EN 12464-1, replace the previous European calculation method (NB-method). The demands on the glare index documented in EN 12464-1 refer to the highest average value for the lighting. The UGR-method (Unified Glare Rating) is described in CIE's publication no 117-1995.

The UGR glare index for discomfort glare is ranked on a scale, which in practice runs from 13 to 28 where the higher the glare index the higher the level of glare. The smallest change in the glare index denoting a significant difference is 3.

The glare number should be calculated according to the 'table method' to check whether the recommended glare index in the standard's tables is met by a specific lighting installation. (The method is described in CIE's publication no 117-1995). However, this method assumes that the luminaires in the room are positioned symmetrically and feature symmetrical light distribution across and along the luminaire.

Luminaire manufacturers provide information/table data as a part of the luminaire's photometric data to calculate the lighting installation's glare index.

For more information go to www.barbourproductsearch.info



Discomfort glare from electric light

Discomfort glare is an immediate occurrence and arises from light sources or luminaires whose luminance is greater than the eye can adapt to, but can also become noticeable after a period of time.

The degree of discomfort glare, depends on several factors; the luminance and the size of the glare source, the position of the glare source in relation to the line of sight and the background luminance against which the glare source is viewed.

Consequently, when light planning the luminaire's luminance should always be considered in relation to the background luminance. The closer the dazzling surface is to the eye, the greater the risk of discomfort glare. In open luminaires, especially those for compact and other intense light sources with high luminous flux, it is generally the light source itself or a mirror image in the specular reflector that causes the glare effect. One way to reduce discomfort glare is to use satin matt reflectors and luminaires with a larger surface area.

Discomfort glare can also be reduced by increasing the luminosity on walls and ceiling of a room. This can be achieved in different ways:

- Using luminaires with an uplight component.
- Positioning the luminaire closer to the walls in the room.
- The walls can be lit separately or the luminosity increased by choosing higher reflection factors on the wall surfaces.

Walls that appear brighter in relation to the visual object can create adaptation problems. The luminosity of the room surfaces should therefore be adapted to the visual conditions and be limited as described in the Luminance distribution and luminance limitations chapter.

Discomfort glare from windows

An awkward and unpleasant glare arises when a person looks out of a window in the direction of the sun, or when direct sunlight falls against surfaces within the normal field of vision. In these situations even discomfort in the form of increased heat radiation can also occur. Thus sun screening in some form is necessary in most buildings.

Screening can be achieved through the design of the building, external sun screens, low transmitting glass (sun glass windows) or through Venetian blinds or curtains. Glare can also occur from a diffuse sky viewed through a window. This form of glare can usually be reduced by choosing lighter colours for the walls near the window or by increasing the luminosity of the walls with separate lighting.

Examples of discomfort glare from a window:

- Reflective glare.
- Reflections on visual objects or their surroundings can completely impair sight.

Even if glare does not occur from a luminaire or other highly reflective surfaces, it can occur in the form of reflection. Polished and reflective materials should not be placed in areas where glare can arise, especially in work areas. If polished surfaces cannot be avoided lighter surfaces are more preferable than darker surfaces. An example is a computer monitor screen surface where reflections are usually perceived as more disturbing on monitors with dark backgrounds and light text, than on monitors with light backgrounds and dark text.

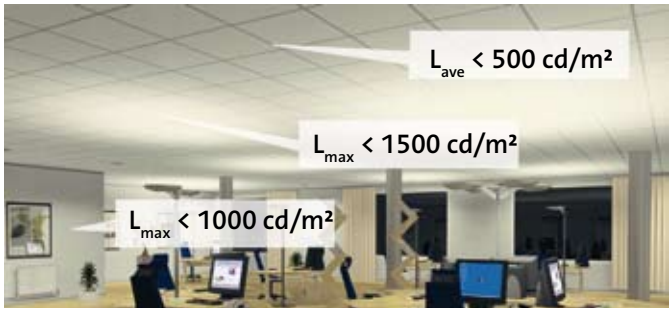
Reflections from reflective materials or reflective glare can usually be prevented with the following actions:

- Suitable luminaire positioning.
- Selecting luminaires with low luminous intensity and effective screening.
- Selecting matt materials for reflective surfaces.
- Selecting luminaires with a larger surface area.
- Select light colours for ceilings and walls.

For more information go to www.barbourproductsearch.info

Recommended luminance conditions between the working area and the room's surfaces

The luminance ratio between the working area and the wall should not be less than 5:1.



With indirect lighting the average luminance on the ceiling should not exceed 500 cd/m².

The luminance from the room's surfaces must be relative to the luminance from the working plane, in order to conform to EN 12464-1 demands. For example, when using low luminance luminaires and downlights, there is a risk that the tops of the walls and the ceiling, may be too dark.

The difference in luminance can be calculated or measured as a relation between different surface luminances. The following luminance conditions are recommended for the workplace:

- The working area (inner field of vision) – immediate surroundings (the near field) 3:1.
- The working area (inner field of vision) – surroundings (adjacent walls within the field of vision) 5:1.
- The working area (inner field of vision) – periphery wall surfaces (background) 10:1.

Later studies, however, show that the luminance relationship between the working area and the ambient area (wall surface) should be 2:1 with an illumination level in the working area of 500 lx. This approach pays consideration to the visual, emotional and biological effects or artificial light and requires that the vertical illumination in work premises should exceed 250 lx.

In order to achieve good visual comfort within an area the average luminance on the room's walls, as a general rule, should not fall below 30 cd/m². It is normal practice to translate luminance conditions to relative illuminance, as illuminances are used as guide values in light planning. Nevertheless, in this context it should be pointed out that today's computerised calculation programs allow the calculation and documentation of different luminances for room surfaces. The table below provides information about recommended relative illuminances between the workspace and room surfaces for a typical area.

Room surface	Recommended reflectance	Relative illuminance
Ceiling	0.6–0.9	0.2–0.9
Walls	0.3–0.8	0.2–0.6
Window wall	> 0.6	0.3–0.6[1)]
Workspaces	0.2–0.6	1.0–
Floor	0.1–0.5	

[1)] The values apply in daylight – without daylight the relative illuminance should not exceed 0.2 provided that the glazed surfaces do not have bright curtains.

Luminance conditions with indirect lighting

With indirect lighting the average luminance on the ceiling should not exceed 500 cd/m², with a maximum acceptable luminance of 1500 cd/m². The luminance transition should vary gradually across the surface being lit to avoid the lighting from being distracting and uneven. The luminance balance (L_{min}/L_{ave}) should not exceed 1:10.

For the background lighting on the walls the maximum luminance should be limited to 1000 cd/m².

Luminance limitation for luminaires that can be reflected in the monitor

Limitations of luminaire luminance at workplaces with monitors classified in accordance within ISO 9241-7	Luminaire's maximum average luminance cd/m² (applies to luminaires that can be reflected on the monitor)	
	Negative monitor polarity (dark background)	Positive monitor polarity (light background)
Monitor class I and II – direct lighting Good, average or normal reflection treatment	≤ 1000 cd/m²	≤ 1500 cd/m²
Monitor class III – direct lighting Inferior screen quality without reflection treatment	≤ 200 cd/m²	≤ 500 cd/m²
Monitor class III – dir./indir. (≥10 % uplight) Inferior screen quality without reflection treatment	≤ 500 cd/m²	–

For more information go to www.barbourproductsearch.info

Flow chart for light planning

1. Analysis of the planning objective

- Define the activities and different visual work that may be performed in the premises at different times of the day.
- Define the lighting demands with regard to safety, visual needs and the visual experience.
- Examine the need for emergency lighting. Define the aims for energy consumption, environment and maintenance of the lighting installation.

2. Analysis of planning conditions

- Define applicable provisions, standards, recommendations as well as special demands from the client and users.
- Define the conditions for lighting the room, the type of workplace and its working area, etc.
- Investigate the conditions for the premises' design, furnishings, type of monitors, flexibility, daylight and the character of the premises.
- Establish the economic prerequisites for the installation and the maintenance conditions for the lighting installation.

3. Overall planning

- Investigate the conditions for interaction between electric light and natural daylight. Check the possibility of daylight screening.
- Investigate which light sources, luminaires and lighting systems best satisfy the demands aims and conditions.
- Investigate the possibilities for lighting control to increase comfort and improve energy usage.
- Investigate the overall co-ordination with other installations, colour setting and furnishings.

4. Detailed planning

- Evaluate the different lighting systems; technically, visually and economically.
- Establish the lighting system's optimal maintenance factors taking the maintenance conditions into consideration.
- Make a financial evaluation by calculating the life cycle costs based on the investment, operation and maintenance.
- Compare the selected lighting systems with regard to other installations, colour setting, furnishings and the chosen equipment.

5. Documentation

- Should be prepared as shown to the right with supplements according to the client's wishes.
- Include Installation drawings, control and assembly instructions as well as associated lists of light sources and luminaires.
- Lighting calculations and visualisations that verify under which conditions the system operates to the specified demands.
- Present calculation prerequisites and the lighting system's maintenance plan (see instructions in the Lighting template).

Interpretation of the calculation result

1. Scrutinise carefully

- To prevent glare – check the luminance conditions in the room.

2. Maintenance factor

- Has the maintenance factor been adapted to a maintenance plan for the lighting installation?

NOTE! The maintenance factor affects the lighting system's energy consumption.

3. Calculation conditions

- Have the conditions for the lighting calculations been checked?
- Has the size of the working area and immediate surroundings been established?
- Has the calculation area for the peripheral area been defined?
- Have the room surfaces' reflectance values been checked?
- Has the luminaire's average luminance been checked in rooms used for monitor work?

4. Uniformity demands

- When calculating the illuminance uniformity i.e. the ratio between the minimum value and the average value in the working area and the immediate surroundings, it is important that the distance between the calculation points is documented. For normal working areas a maximum spacing of 0.25 metres between calculation points applies.

5. Graduation implication

- Use the scales for illuminances and luminances stated in the standard EN 12464-1.

6. UGR-glare index

- Check, where appropriate, that the system's average glare index conforms to the value stated in the standard.

Checking the lighting installation

1. Scope

- What should be evaluated? Electric lighting, emergency lighting, daylight conditions, functionality and control, maintenance plan, electrical efficiency, etc.

• 2. Conditions

- Regarding the control of new systems, which conditions applied when planning?
- Evaluation of existing systems?
- Evaluation with or without daylight?
- Are the measured values new values or maintained values?

3. Implementation/checks with light measurement

- Illuminances – mean value/uniformity for the working area, immediate surroundings and the lowest illuminance within peripheral areas.
- Luminaires' mean luminances.
- Calculate where appropriate the UGR-glare index.
- Luminance conditions in the premises.
- Luminaire's cut-off angle.
- Light sources' colour reproduction and colour temperature.
- Perform visual evaluation and interview personnel.
- Perform a functional check.
- Check the calibration, burn-in time and prevailing operating conditions before light measurement.

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Energy efficiency in lighting installations

A lighting installation needs to confirm to the various requirements stipulated for its specific area, without compromising on energy efficiency or visual comfort. This necessitates that care consideration is paid towards the selection of the appropriate lighting system, equipment, control systems and the use of daylight. A measurement of efficiency in a lighting installation is the installed output, in W/m², that is required to meet defined demands.

Example of installed lighting outputs

Installation type	Installed lighting output	Required illuminance while operational (lx)	Notes.
Corridors	5–10 W/m²	100 lx	
Corridors	10 W/m²	200 lx	
General public areas	10–12 W/m²	300 lx	
Workplaces	10–12 W/m²	300 lx	*)
Workplaces	10–15 W/m²	500 lx	*)
Workplaces	15–30 W/m²	1000 lx	*)

**) Required illuminance within the working zone according to EN 12464-1. The lower value normally presupposes a localised lighting system adapted to the working area in the workplace.*

General advice

The following points should be considered in order to create low energy usage in a lighting installation:

- Selection of light sources with optimal luminous efficacy for the required colour reproduction.
- Energy efficient lighting system with installed lighting output suitable for the required task.
- Efficient luminaires with the correct light distribution and good cut-off properties.
- Efficient utilisation of daylight.
- Efficient utilisation of artificial and natural light through the selection of a light interior colour scheme.
- Control of lighting through presence detection.
- Possibility of localised control by the individual.
- High frequency operation with dimming.
- Well planned maintenance of the lighting installation to obtain a high maintenance factor.

Evaluation of a lighting system

Visual ergonomic aspects of the workplace's design are important for a stimulating working environment. There is an excellent method called "visual evaluation" available to review and assess a room with an installed lighting system, which is simply based on describing what you see in the room.

Evaluate the room visually through its lighting system, colours and design. These factors affect each other and are difficult to assess individually. The room colours should not be distorted, and visual work should be possible without the discomfort of glare or reflections.

The room's visual quality governs, to a large extent, your health and your performance capacity. It is therefore important that you do not completely rely on computer calculated results. Try to make a visual evaluation of your own workplace using the adjacent table. Rank the opposite pairs on a scale of 1–5.

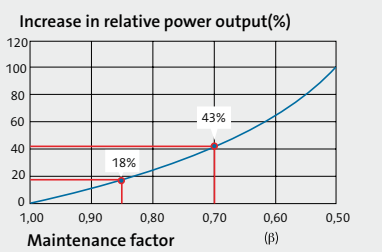
In addition to a low installed output, energy usage should be limited in an installation with the help of different control systems.

A better method of assessing the energy efficiency of a lighting system is to evaluate the annual energy consumption. This method is described in the EN 15193 standard, which is linked to the Energy Directive, see pages 511–514.

The maintenance factor affects energy consumption

The new standards give light planners greater responsibility for the system, as the installation's maintenance factor has a direct effect on the energy consumption. To select a high maintenance factor a great deal of care must be exercised when choosing light sources, luminaires and the lighting system. The choice of T5 luminaires gives the best conditions for achieving a high maintenance factor.

For further information on calculating the maintenance factor, refer to the SLL Code for Lighting.



Concept	Description	Evaluation
Light level	– is it dark or light in the room?	dark – light
Light distribution	– how is the light distributed in the room?	varied – equally
Light colour	– is the light colour experienced as warm or cold?	warm – cold
Colour	– how are the colours and objects viewed?	distorted – natural
Glare	– does unpleasant glare occur?	troublesome – not noticeable
Shadows	– whether they are hard or soft?	hard – soft
Reflections	– whether they are intense or diffuse?	intense – diffuse

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Light, or light radiation, not only affects our visual cortex but also the whole of our alertness, wellbeing and performance. Our circadian rhythm and seasonal variation are genetically fixed, but they are regulated to a certain extent by our surroundings, above all by light. Nerve pathways from the eye's retina signal to cells in the brain to stop secreting the hormone melatonin, which is believed to control our circadian rhythm. Interruptions to the circadian rhythm, due to a lack of daylight during the winter months, is considered to be the primary cause of seasonal affective disorder (SAD).

The effect of light on humans

New research has shown that light also affects a new third receptor as well as both the rods and cones. A discovery which has been identified as the missing link between how our health and wellbeing are connected to light.

This receptor affects different hormones in the brain such as the secretion of the sleep hormone melatonin, which is produced at lower light levels or in the dark. Conversely, at higher light levels, the stress hormone cortisol is produced. For 150 years, we have focused on the visual effects of light, but with the discovery of the new receptors we must also in future take into account the biological and emotional effects of light on man.

Increased demands on lighting planning

In order to gain a greater understanding of how light in our surroundings effects our wellbeing Fagerhult's Lighting Technology Manager Tommy Govén, in conjunction with Professor Thorbjörn Laike from the Department of Architecture and Built Environment at Lund University, have conducted an application study on the subject.

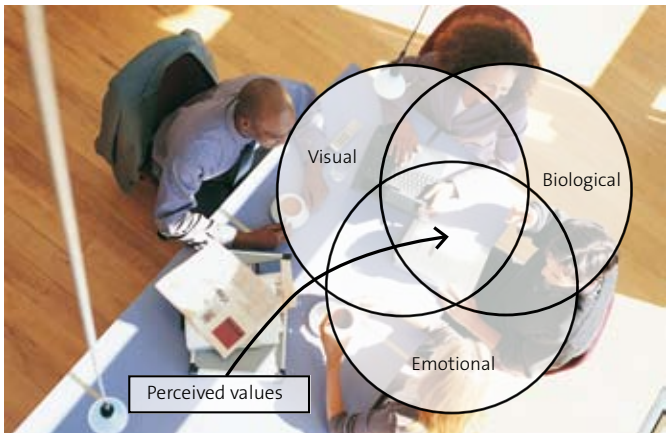
The study shows that the body is influenced to a great extent by normal ambient light at ± 30˚ in the horizontal line of vision. The most positive effects with regards to human alertness, wellbeing and performance are observed at approx. 100 cd/m² on walls with a horizontal illuminance of 500 lx.

100 cd/m² seems to be an optimal level for vertical ambient light – something which poses questions about current lighting levels in offices, which is usually three to four times lower (20–30 cd/m²). The study also showed that ambient light influences the stress hormones in the body and alertness in a relatively short time. It is therefore possible, by using algorithmic lighting controls, to change our biological clock over time. For example, in the morning during the dark months of the year, increase activity with more ambient light.

How is lighting planning affected?

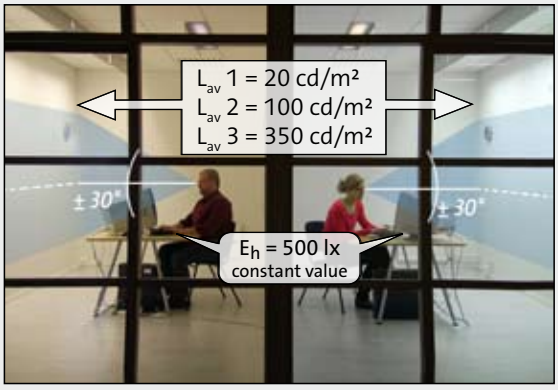
The discovery that certain elements of light radiation also affect our wellbeing will influence the future design and evaluation of lighting in our rooms.

This may lead to a greater focus on the lighting of our surroundings but also on varying light and its colour over time. This will be especially important in rooms that do not have a supply of natural daylight. Within healthcare, light has long been used for the medical treatment of skin conditions and in order to reduce the effects of SAD (seasonal affective disorder). In the future, lighting planning will be more focused on visual, biological and emotional aspects.



In the future, lighting planning will be more focused on visual, biological and emotional aspects.

Methodology of the test



The study clearly shows that the body is influenced to a great extent by normal ambient light at ± 30˚ in the horizontal line of vision. The most positive effects with regards to human alertness, wellbeing and performance are observed at approx. 100 cd/m² on walls with a horizontal illuminance of 500 lx.

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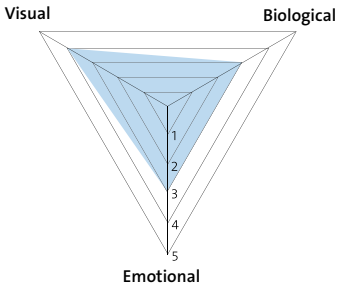
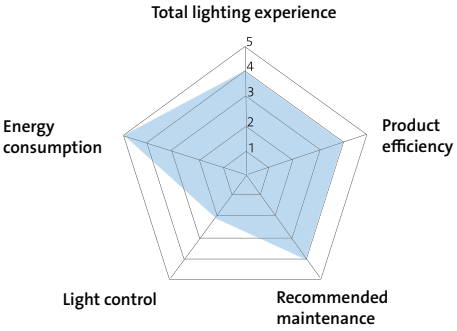
VBE- and AQ-index

Human index for the room's lighting experience and the lighting's total quality index





The parameters for the VBE index are presented in a triangle. Each parameter is valued on a scale of 1–5, where 3 corresponds to the normal value. The total VBE index can therefore be a maximum of 15. The higher the total index, or the filling of the triangle, the better the total lighting experience. As an example for workplaces – work surfaces – the visual aspects have the greatest significance.

The criteria for the AQ index is shown in a pentagon. Each criterion is valued according to a scale of 1–5. The higher the total index, or the filling of the pentagon, the better the system solution's index for the room. The Lighting Concept Tool shows how the AQ index changes when wall lighting and lighting control is added.

VBE index

Through research we now know that light affects us not just visually, but also non-visually. Traditionally lighting quality was only described visually within a space by stating the illuminance within the working area and its immediate surroundings. However, research has shown that ambient lighting, the lighting of walls and the ceiling, has a significant effect on us both biologically and emotionally (non-visually). The level of ambient light is important for our alertness and therefore our ability to perform over time.

The VBE index is a model that describes a way to interpret the lighting experience within a room visually, biologically and emotionally. The aim of the VBE index is to describe the subjective lighting experience – where all parameters have significance and can be weighted differently depending on the type of room and the activity. The model aims to be a support and communication tool in the dialogue between the buyer and the lighting planner and can be used for different types of environment, e.g. work, restaurant and care environments. The template can also be used as a basis for evaluating the existing facility.

The model for the evaluation of the quality of the lighting solution, with man in the centre, is based on a subjective evaluation of the visual, biological and emotional aspects where the overall perception of a lighting solution is taken into consideration. The different parts are individually evaluated and the sum gives a total VBE index through the use of certain assumed parameters and the value of these. The better the correspondence with the input parameters, the higher the overall points for VBE.

AQ index

There are ever increasing demands on the reduction of energy consumption, for both economic and environmental reasons. The need to be able to value the overall light quality in a room, both with respect to the lighting experience and the operating cost, was the inspiration behind the AQ index.

The AQ index (Application Quality Index) is a model that describes a way to interpret the lighting experience together with parameters which show energy consumption and operating costs for a specific room.

The lighting solution's quality index is based on five different parameters with the aim of showing the total quality of a lighting installation for a specific room. The operating cost parameter takes the energy consumption, product efficiency, illumination and the recommended maintenance of the lighting within a room into consideration.

The value of all the parameters is based on the different criteria, which are shown in the form of a table. The final presentation which appears in the pentagon should be seen as a value of system solutions within the room – the room's lighting experience together with the energy consumption and operating cost of the lighting. The evaluation is normally made by a lighting planner at the design stage, but can also be carried out by an inspector on an existing installation.

Aspects of the VBE index

The visual aspects
include the more traditional fundamental values such as the visibility of an object, visual comfort, contrast, glare etc. over time.

The biological aspects
are primarily due to our biological clock – the body's endocrinal hormone secretion and its influence on our alertness, wellbeing and performance both during the day and for the different seasons. Research shows that the body is mainly affected by the level of ambient light and its spectral composition.

The emotional aspects
are the most subjective – how we generally perceive the light in a room, the colour of surroundings and the light's colour, dynamic and comfort over time.

Parameters for evaluation of the total AQ index

Lighting experience
is based on the total VBE index, i.e. a subjective evaluation of the visual, biological and emotional parameters within the room.

Energy consumption
describes the energy consumption and is valued according to the room's calculated LENI figure in accordance with EN 15193. The calculated LENI index describes the room's energy consumption expressed in kWh/m² per year.

Product efficiency
for luminaires including light sources – stated as an LLE index for all luminaires in the room. The calculated LLE value is expressed in lm/W.

Lighting control
describes which type of control system is used in the room.

Recommended maintenance
is the interval for maintenance of the lighting in the room, with regards to cleaning, servicing and changing light sources, recommended by the lighting planner.

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Light measurement

The luminaire's light distribution is measured on several C-planes around the luminaire, at intervals of at least 15°. First measurement plane (C=0°) is across the lamps' longitudinal axis. γ-angles – several angles are measured, at least every 5 degrees (see figure).

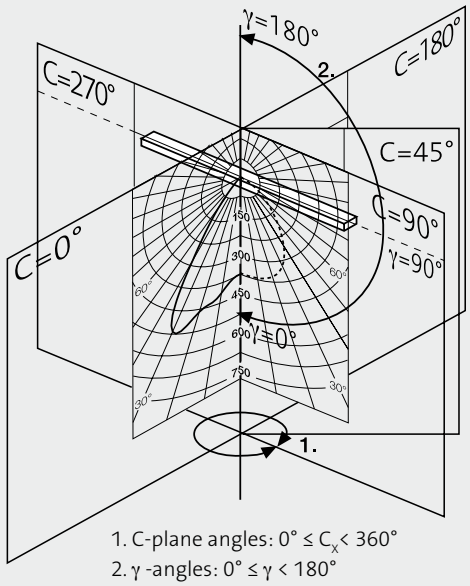
Light distribution curve

The light distribution curve drawn in a polar diagram denotes the luminaire's luminous intensity in different directions as a function of viewing angle in one or more planes. It is usually represented by an unbroken line that indicates the light distribution perpendicular to the light source's longitudinal axis and with a dashed line that indicates the light distribution in direction of the longitudinal axis. The values of the light distribution curves are scaled to correspond to 1000 lm from the light source (cd/1000 lm, cd/ klm). This is why it is often possible to show luminaires with different outputs on a common polar diagram.

Isolux diagram

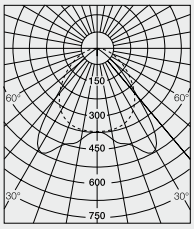
The diagram shows, using curves (or scales) a predefined area, inside which the horizontal illuminance exceeds the curve's lux value. The position of the luminaire is usually indicated on the diagram. Alternatively, the isolux diagram can be represented by a 3D diagram, which is best suited for showing the uniformity of the lighting installation. The calculation points' illuminance values can be introduced onto the premises' layout drawing and the results given in table form. The results are available in all the above mentioned forms in DIALux.

Light measurement

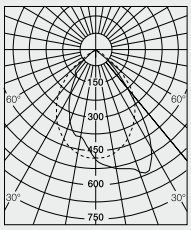


1. C-plane angles: $0° \le C_x < 360°$
2. γ -angles: $0° \le \gamma < 180°$

Light distribution curve

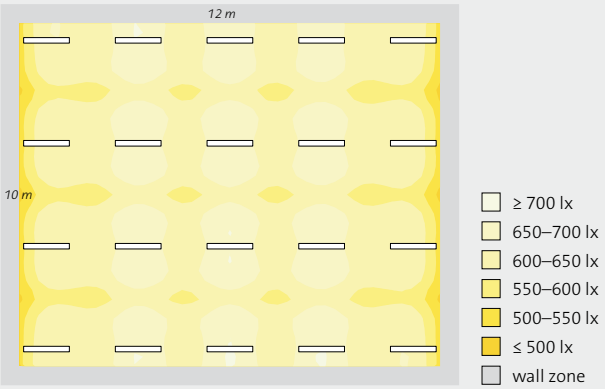


Symmetrical light distribution
A 28 W fluorescent lamp (2600 lm) gives, directly beneath it, approximately 375 cd/klm.



Asymmetrical light distribution
At a maximum luminous intensity angle of 25° a 28 W fluorescent lamp gives approximately 580 cd/klm.

Isolux diagram



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Luminance classification of decorative luminaires with opal surfaces

In order to facilitate the selection of luminaires with luminous opal surfaces, Fagerhult has developed a classification system that documents the average luminance for this type of luminaire.

The affected luminaire types are pendant, ceiling and wall as well as any other luminaire with opal luminous surfaces. Luminance classification should be used as a reference to assess the desired luminaire in relation to the luminance of the surroundings and how they are experienced.

The luminance values documented in the tables have been measured square to the luminaire and make up an average value for the luminaire's luminous surfaces. A luminaire range can be classified in several luminance classes depending on the output of the light source that the luminaire is fitted with.

Luminance classes for luminaires with opal surfaces

Luminance class [1)]	Average luminance	Considerations:
A	< 1000 cd/m²	The luminaire has a low average luminance and can be used in rooms with high anti-glare requirements e.g. offices with ordinary monitor work.
B	1000–3500 cd/m²	The luminaire has relatively low average luminance and can generally be used in most situations. Against a light background the risk of glare is small.
C	3500–5000 cd/m²	The luminaire has a relatively high average luminance and should therefore be used in bright surroundings to avoid glare.
D	> 5000 cd/m²	The luminaire has a high average luminance. The risk of glare can be large even if the luminaire is used in very light surroundings. The luminaire should therefore be avoided in rooms within the normal field of vision.

Key to the table

[1)] If the luminaire's luminance balance exceeds 4:1 this is denoted with the additional designation – example B*. The luminance balance is defined here as $L_{max} / L_{average}$.*

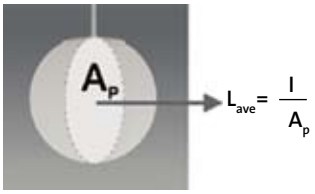
The surroundings can be regarded here as light if the average value of the background luminance exceeds 20 cd/m² within a normal field of vision of ±20 degrees from a horizontal visual plane.

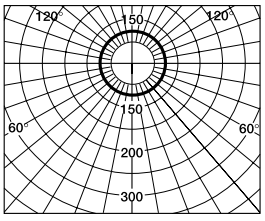
In order for the background luminance to exceed 20 cd/m² , the average vertical illuminance should exceed approx. 75 lx against a light wall. Investigations show that the relationship between the luminaire's average luminance and background luminance should not exceed 40:1.

Globia luminaire. See the product page for luminance classification information.

Light measurement and calculation of documented table values

Luminaire's average luminance (cd/m²) – calculated from the luminaire's technical data.





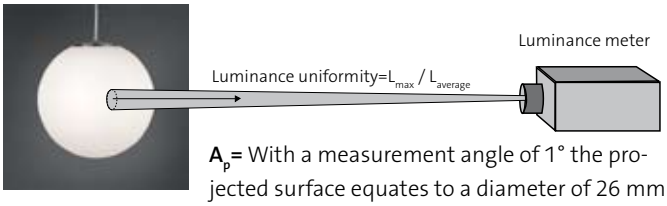
Polar diagram cd/1000 lm

I = the luminaire's luminous intensity square to the luminaire's luminous surface (cd).

$\mathbf{A_p}$ = luminaire's projected luminous surface (m²).

$\mathbf{L_{average}}$ = luminaire's average luminous intensity (cd/m²).

The luminaire's maximum surface luminous intensity (cd/m²) – measured using a luminance meter with a measurement angle of 1°.



A_p= With a measurement angle of 1° the projected surface equates to a diameter of 26 mm (500 mm²) at a distance of 1.5 m.